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SURFACE REMEDIATION FEASIBILITY STUDY REPORT FOR THE TRW SITE IN MINERVA, OHIO

Final Report

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I. INTRODUCTION

The conclusions presented in this report are the product of an extensive study of PCBs and volatile organics at the TRW, Inc., site in Minerva, Ohio. The planning, execution, and results of that study are also documented to serve as a record tracing the development of the proposed surface remediation plan for the Minerva site. However, since much of the information presented in this report has already been documented elsewhere, references and citations to other documents will be employed frequently to promote brevity. To facilitate evaluation, the format of this report parallels the "Generic Remedial Investigation/Feasibility Study Statement of Work" (GSOW) provided to TRW by the Ohio Environmental Protection Agency (OEPA) in August 1984.

This report contains three main sections that follow the introduction. Since the GSOW requires that the current situation at the site be documented at the start of both the remedial investigation and the feasibility study (Tasks 1 and 7 of the GSOW, respectively), a detailed description of the current situation at the site and an overview of the historical development of information on it are presented in Section II, "Site Background." Section III, "Remedial Investigations," serves as the final report for the extensive field studies conducted at the TRW site (Task 5 in the GSOW). Section IV, "The Feasibility Study," serves as the final report listed in Task 14 of the GSOW.

APPENDICES

Appendix 1. Modifications to the Proposed Excavation and Secure Cell Construction for Surface Remediation at the TRW Site

Appendix 2. a. Work Plans for the Installation of Monitoring Wells Already Present at the TRW Site

b. Work Plan for Establishing Groundwater Sampling Protocols for PCBs

Appendix 3. Work Plans for Soil and Sediment Sampling Conducted at the TRW Site (In Chronological Order)

Appendix 4. Specifications for Laboratory Quality Assurance Procedures for the TRW, Minerva Site

Section III and IV are also arranged by subsections that parallel the tasks outlined in the GSOW.

There are three major documents that TRW has already provided to the United States Environmental Protection Agency (USEPA) and OEPA during the course of the studies conducted at the Minerva site. These contain most of the information requested in the GSOW and will be cited frequently in this report. They are:

- "Characterization, Risk Assessment and Remedial Action Plan for a PCB Spill at the TRW Site in Minerva, Ohio." Prepared for TRW, Inc., by Clement Associates, June 20, 1983 (Clement 1983a).
- "Enclosure to Letter of December 20, 1983 from Mr. William R. Phillips (TRW) to Mr. Basil G. Constantelos (USEPA)." Prepared for TRW, Inc., by Clement Associates, December 20, 1983 (Clement 1983b).
- "Characterization, Risk Assessment, and Remedial Action Plan for Volatile Organic Contamination at the TRW Site in Minerva, Ohio." Prepared for TRW, Inc., by Clement Associates, August 27, 1984 (Clement 1984).

Appendix A to the Clement 1984 report--"Preliminary Engineering Design, Minerva, Ohio Site," prepared for TRW, Inc., by O'Brien and Gere, December 20, 1983 (OBG 1983)--will also be cited frequently.

In addition, there have been several internal documents generated during the course of the investigations at the Minerva site that also contain information requested in the GSOW. These will be cited and provided as appendices to this document as needed.

II. SITE BACKGROUND

A. Site Description

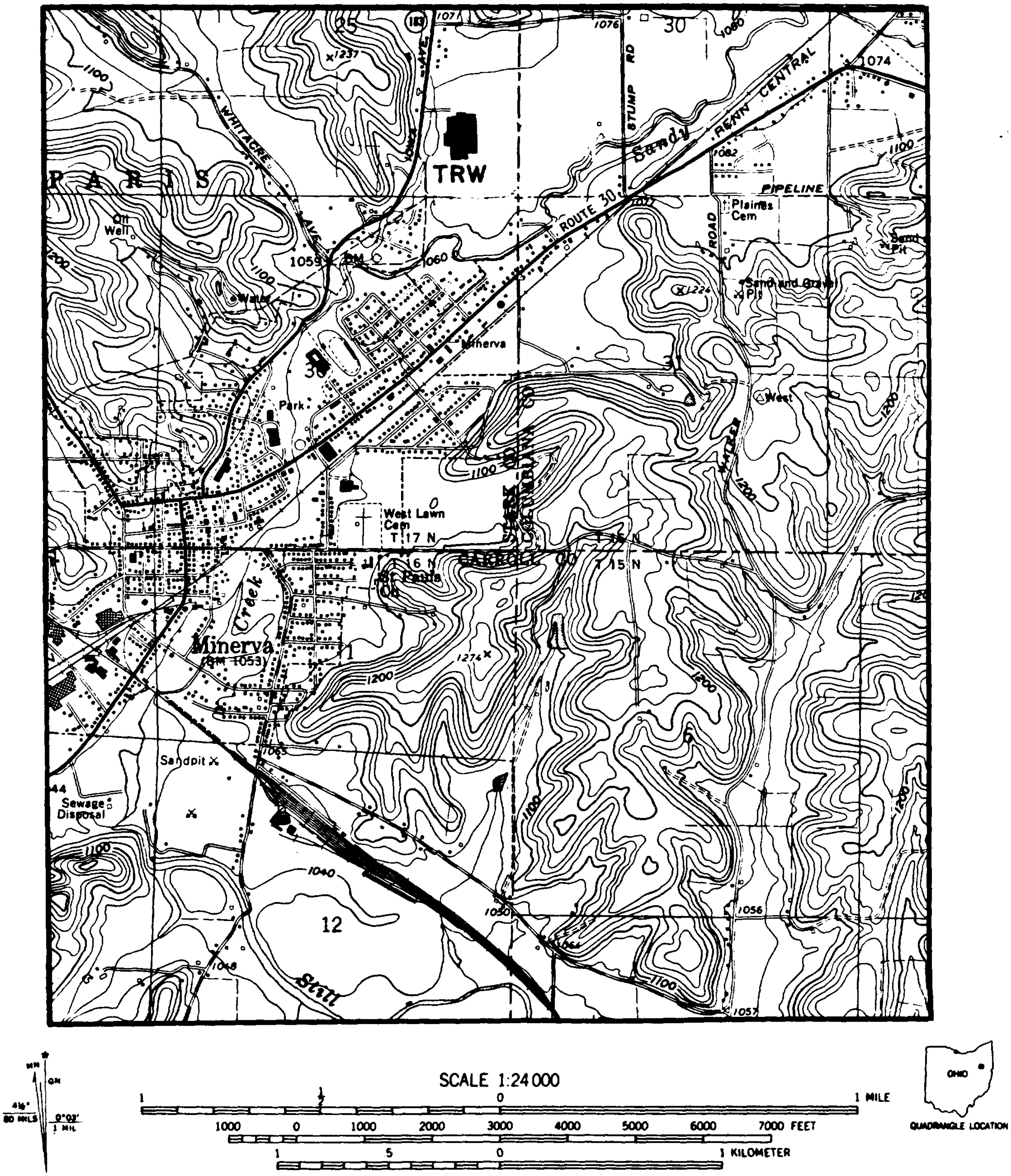
The TRW site in Minerva, Ohio, is located in the town of Minerva, Stark County, Ohio. The plant site is adjacent to State Road 183, approximately 1.3 miles northeast of the intersection of Route 183 and U.S. Route 30, as indicated in Figure 1.

The initial site was purchased in 1954 and has been expanded twice by the subsequent purchases of adjacent properties. Property boundaries and other site features are depicted in Figure 2. The plant lies on a relatively flat, 54-acre parcel with farmland located to the north and east. TRW also owns 56 acres of hilly terrain west of Route 183. Except for a narrow strip immediately adjacent to Route 183, however, the property west of 183 has never been developed and is not a focus of this study. The approximately 25-acre parcel south of the plant, which extends to Sandy Creek, was purchased by TRW from R.F. Fry in 1982 and is now referred to as the South Property. In 1984 TRW also purchased a 250-foot wide strip of land east of the plant site, which extends to the Stark County line, from R and M Unkefer. This will be termed the East Property.

In addition to the plant itself, important features located on the TRW property include a drainage swale running along the eastern and southern borders of the plant; an ornamental

FIGURE 1

LOCATION OF THE TRW SITE IN MINERVA, OHIO



lake, West Lake, located west of the plant; a discharge stream running from West Lake to Sandy Creek; a drainage lagoon, South Pond; the wax ditch, which runs from the plant to South Pond; and a rubble pile located east of South Pond. Twenty-two monitoring wells have also been installed on the property and more are planned. A detailed physiographic description of the site is presented in the report submitted in June 1983 (Clement 1983a). A topographic survey map of the site was provided as part of the appendix (OBG 1983) that was presented to the OEPA and USEPA in December 1983. It should be noted that the survey map will be updated and expanded to include all of the South and East Properties as part of a groundwater feasibility study currently in progress. The revised survey will be available early next year.

The TRW site is located on glacial till that is over 90 feet thick and contains a productive aquifer. The surface soil is chile silt loam, and the till becomes increasingly gravelly with depth. The glacial till in this area is underlain by a limestone-shale bedrock. Details of the area geology and hydrology were presented in the June report (Clement 1983a). Additional site-specific geologic and hydrogeologic information is also being developed as part of the ongoing groundwater feasibility study and will be available early next year.

Both PCBs and volatile organics were used at the TRW site and were introduced into the environment as a consequence of materials handling; this site has never formally been used to dispose of hazardous wastes. The TRW plant houses a metal casting operation, and PCBs were used as working fluids in diffusion pumps until 1976 when their use was discontinued. Spent PCBs were stored in drums on the back pad of the plant and apparently leaked into the drainage swale adjacent to the pad. In addition, waste washwater and spent casting wax from the operation, which may have come into contact with PCBs, were discharged into the wax ditch and subsequently flowed into the South Pond. Dredged material from the South Pond and wax ditch were also deposited on the rubble pile. In addition, volatile organics (specifically, trichloroethene prior to 1972 and 1,1,1-trichloroethane since 1972) were used as degreasers in the plant; spent degreasers were discharged directly to the wax ditch.

B. The Nature and Extent of the PCB and Volatile Organics Problem

In August 1981, TRW, Inc., notified USEPA and OEPA that PCBs had been detected in soils at the TRW plant in Minerva, Ohio. Following the discovery, TRW retained Clement Associates to conduct a thorough assessment of the extent and distribution of PCBs at the site, evaluate the potential for off-site movement of PCBs, assess the potential health and environmental risks posed by the presence of PCBs at the site, and provide guidance in selecting appropriate remedial measures.

Details of Clement's study were provided in two reports submitted to USEPA (Clement 1983a,b). During this investigation (conducted between August 1981 and June 1983), PCB residuals were detected in several areas of the Minerva site, including the swale, the South Pond, the wax ditch, and the rubble pile, as depicted in Figure 3. Additionally, a narrow strip of land on the South Property exhibited surficial PCB contamination. In all cases, the PCB residuals are associated with solid, soil-type matrices (including swale sediments, South Pond sediments, rubble pile soils, South Property soils, and wax ditch residues). There are no waste drums or tanks containing PCBs on the property. The volumes and locations of the PCB-containing soils present at the site are summarized in Section III of this report and were detailed in an earlier document (Clement 1983a).

The risk assessment conducted as part of the PCB investigation (see Clement 1983a) indicated that the levels of PCBs found at the site pose a negligible risk to public health and the environment. The transport processes considered include volatilization, storm runoff, and percolation to groundwater. Potential receptors identified as part of this study were site workers, local groundwater and surface water users, and residents living downwind of the facility.

Although the results of the risk assessment indicated that the potential risks posed by the presence of PCBs at the site are neglibible, TRW undertook to evaluate remedial alternatives and develop a plan to reduce such risks to uniformly insignificant levels. Details of the identification, screening, development, and selection of remedial alternatives are presented in Section IV of this report.

Upon the discovery of volatile organics in groundwater at the TRW site, a second investigation was initiated in the spring of 1984 to assess the extent and distribution of volatile organics at the site, evaluate the potential for off-site movement, determine the effects of potential interactions between PCBs and volatile organics, assess the potential health and environmental effects posed by the presence of these volatile organics, and assist in identifying and selecting appropriate remedial measures.

During this second investigation (conducted in June and July of 1984), concentrations of 1,1,1-trichloroethane (TCA) and traces of trichloroethene (TCE) were detected in wax ditch residues, South Pond sediments, and a localized hot spot in the rubble pile. In addition, TCE, 1,1-dichloroethane, trans-1,2-dichloroethene, and lower concentrations of TCA, 1,2-dichloroethane, 1,1-dichloroethane, and traces of several other compounds were detected in groundwater samples collected from monitoring wells at the site. Details of this study are provided in a report submitted to USEPA and OEPA in August 1984 (Clement 1984).

The risk assessment conducted as part of this second investigation indicated that both the potential for migration of volatile organics from soil matrices on the site and the continued migration of volatile organics already present in the groundwater could potentially pose a risk to human health or the environment and, therefore, needed to be addressed as part of an overall site remediation plan (for details, see Clement 1984). The migration pathways for volatile organics considered as part of this risk assessment include volatilization and percolation to groundwater. The potential receptors include site workers, residents living downwind of the site, and local users of groundwater and surface water. The principal pathway of concern identified in this study was the percolation to groundwater and subsequent movement within the groundwater to potential receptors (through drinking water wells or surface streams).

The remedial alternatives identified as being potentially appropriate for addressing the problem of possible volatile organic migration from the TRW site (detailed in Section IV of this report) indicated that a two-track approach would expedite the solution. The decision was therefore made to treat the surface problem and the groundwater problem separately. Preliminary indications suggested that, with minor modifications, the surface remediation plan proposed for PCBs at the site would also effectively remove potential sources of volatile organics. Information required to modify this plan would be collected as part of a surface remediation feasibility study, which would be completed rapidly to facilitate the early approval of the plan necessary to allow remediation to proceed during the 1985 construction season. This report is the culmination of the surface remediation feasibility study.

The groundwater problem requires more extensive study before an appropriate remediation plan can be finalized. Thus, a groundwater feasibility study, designed to address the remaining information needs for designing the groundwater remediation plan, is currently in progress. The results of the groundwater study will be available early next year.

C. Site History

A history of the site, including site investigations, cleanups, and other responses to the discovery of PCBs and volatile organics on site, is summarized in the following chronology.

Date	Event
08/07/81	OEPA and USEPA notified by TRW that PCBs discovered on property
08/10/81	Telephone conversations to assess severity of problem
08/18/81	Mark Torf (OEPA) visits site and collects oil and sediment samples (samples split with TRW)
08/21/81	TRW makes presentation on status of site at West Lake, Ohio, office of USEPA
08/22/81	USEPA staff visit site and collect soil, oil, wax, and sewer water samples (samples split with TRW)
08/25/81	Wax ditch oil slick removed by Emergency Response and Environmental Restoration of New Jersey; waste sent to a secure landfill

08/27/81	USEPA staff conduct a PCB-TSCA (Toxic Substances Control Act) inspection of the site
08/81	OEPA staff test local private wells for PCBs
09/01/81	TRW retains Clement Associates to assist in investigating this problem
09/14/81	USEPA staff visit site and sample production wells and well at TRW barn (samples split with TRW)
12/21/81	Initial field investigation by Clement Associates begins
02/04/82	Installation of 18 monitoring wells initiated
05/14/82	TRW provides status report to OEPA by letter
05/19/82	TRW presents status of site to OEPA at TRW
07/06/82	Groundwater monitoring begins at the site
08/26/82	USEPA staff visit site and collect water samples from barn, production wells, and sanitary sewer (samples split with TRW)
09/09/82	Comprehensive soil and sediment sampling begins
10/25/82	Four additional monitoring wells are installed on the South Property
06/20/83	TRW presents conclusions of PCB investigation to USEPA and OEPA in Chicago
07/10/83	TRW retains O'Brien and Gere to assist in the design of remediation
12/20/83	TRW presents a surface remediation plan to immobilize PCBs at the site to USEPA and OEPA in Chicago
02/21/84	TRW presents status of site to OEPA in Columbus

03/20/84	OEPA performs RCRA (Resource Conservation and Recovery Act) inspection of site
06/84	Volatile organics discovered in groundwater at TRW site
07/11/84	Volatile organic field investigation commences
08/29/84	TRW presents a revised remediation plan to OEPA in Columbus and proposes the feasibility studies required to implement the plan
09/15/84	Groundwater feasibility study begins
09/15/84	Surface remediation feasibility study begins

FIGURE 2

SITE PLAN AND SITE BOUNDARIES FOR THE TRW PROPERTY IN MINERVA, OHIO

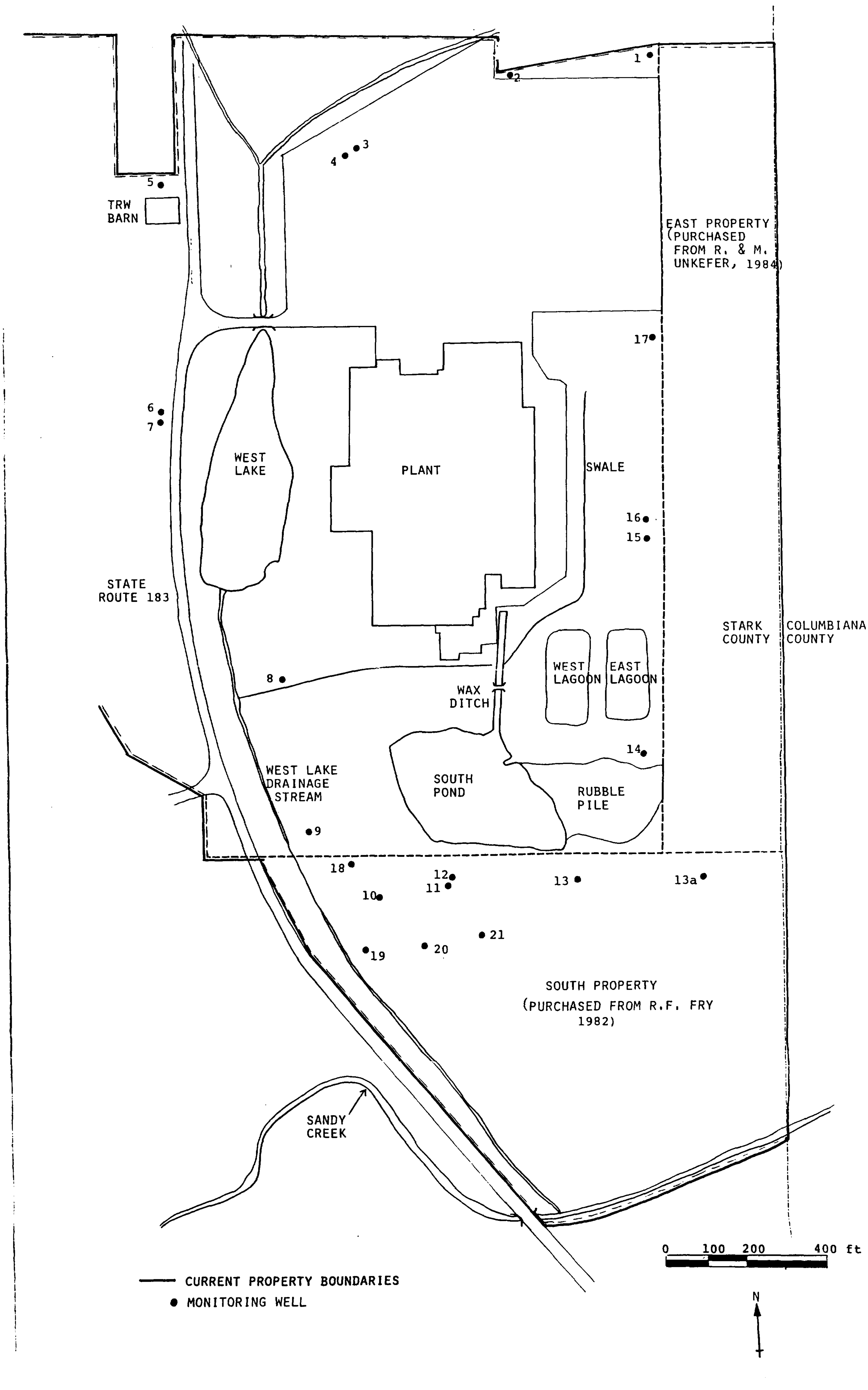
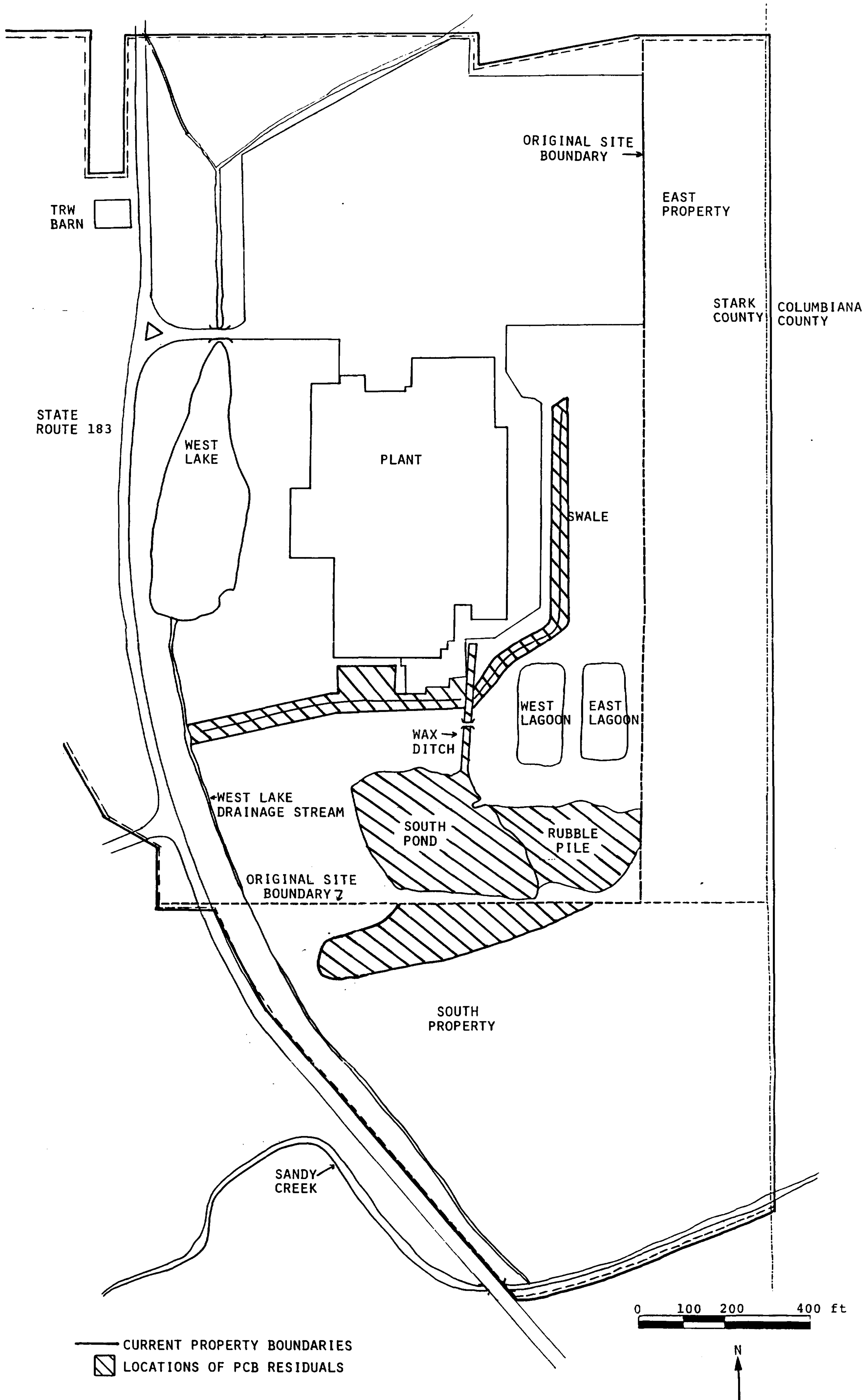


FIGURE 3

LOCATIONS OF SOILS CONTAINING PCB RESIDUALS ON THE TRW PROPERTY IN MINERVA, OHIO



III. REMEDIAL INVESTIGATIONS

This section summarizes the results of several field investigations conducted at the TRW site to determine the extent of PCB and volatile organic contamination at the site. The section is arranged by tasks to facilitate direct comparison with the GSOW developed by OEPA.

Task 1. Description of Current Situation

The current situation is detailed in Section II of this report.

Task 2. Investigation Support

Field investigations at this site were conducted in several phases. Prior to each phase of the investigation, available site data were evaluated to determine the objectives of the investigation to be conducted, the overall design of the investigation (including boundary conditions and the establishment of site security), and quality control/quality assurance and health and safety considerations.

a. <u>Health and Safety Plans</u>

(1) Summ[illegible] list — type heading [illegible] respiratory

All field investigation work plans developed for the TRW site contained a section addressing health and safety. Health and safety plans for the site required that the following protective gear be worn by field investigators in contaminated areas at all times:

- Tyvek suits (disposable)

- Neoprene rubber gloves (disposable)
- Rubber boots (disposable)

b. Boundary Conditions

Details of the site's boundary conditions are provided in Section II and depicted in Figure 2. Areas where PCBs and volatile organics have been detected are depicted in Figure 3. In the proposed surface remediation plan, work zones, contaminated zones, points of access, decontamination areas, and clean zones have all been demarcated based on known conditions at the site (OBG 1983).

c. Site Map

A site map depicting the current topology of the TRW site was presented in Section II of this report (Figure 2). Detailed site maps depicting past sampling locations were provided in earlier reports (Clement 1983a,b, and 1984). Sampling locations are discussed further under Tasks 3 and 4 of this section. Sampling maps were based on a grid laid out on an early site survey and are referenced to that grid system. Detailed survey maps depicting all proposed work are presented in an addendum to an earlier submittal (OBG 1983). The addendum is provided as Appendix 1 to this report.

d. Preinvestigation Evaluation

Prior to the initiation of any phase of the field investigations conducted at the TRW site, a detailed evaluation was performed to define the objectives of the study. Objectives were generally stated in the introductory sections of each work plan. Work plans discussed under the following tasks were originally prepared as internal documents and are provided as Appendices 2 and 3 to this report.

Task 3. Remedial Investigation Work Plans

Two major remedial investigations were conducted at the TRW site. The first investigation, which was carried out in several distinct phases, was designed to determine the nature and extent of PCB contamination at the site. Potential migration pathways for PCBs were also examined. Based on data developed from earlier sampling conducted by USEPA, OEPA, and TRW, several work plans were developed to complete the determination of the distribution of PCBs in soils and sediments at the site and to examine the extent of PCB migration in surface water and groundwater.

After volatile organics were detected in groundwater at the site in early 1984, a second remedial investigation was conducted to determine the level and distribution of volatile organics at the site. Potential migration of volatile organics was also examined. An additional concern, the possibility that the presence of volatile organics might enhance the migration of PCBs, was also considered. A phased work plan was developed that outlined a program for collecting the required information on volatile organics.

a. Waste Characterization

Wastes at the TRW site consist solely of soil-type matrices containing PCBs and/or volatile organics. There are no free organic liquids at the site nor any tanks or drums containing PCBs or volatile organic wastes. The characterization of these wastes therefore focused primarily on determining the location, volume, and concentration of contaminants within the various soil-type matrices. It should be noted that since all wastes at the site have similar components, compatibility was not an issue.

b. Hydrogeologic Investigation

Twenty-two monitoring wells were installed at the Minerva site in two phases as part of the overall remedial investigation. Locations for the wells, well specifications, and installation and development protocols were provided in two work plans (one issued for the first 18 wells and a second, for 4 additional wells), which are presented in Appendix 2. Since the initial purpose of the wells was to determine the potential impact of PCBs detected in soils at the site, protocols for a PCB sampling program were presented in a monitoring work plan also provided in Appendix 2. Information on local groundwater flow characteristics was also collected from these wells.

When volatile organics were detected in groundwater at the site, sampling protocols for volatile organics were also developed (Clement 1984). Based on the results of volatile organic monitoring in the existing wells, a more sophisticated groundwater monitoring program (including the installation of additional wells) was deemed to be warranted. A work plan for this new groundwater monitoring program, "Proposed Groundwater Treatment Feasibility Study for the TRW Site in Minerva, Ohio," is being submitted under separate cover.

c. Soils Investigation

As a picture of historical PCB-use patterns emerged and the potential mechanisms for spreading PCBs to different areas on the site became apparent, the sampling was expanded to include new areas. Ultimately, the swale, the wax ditch, South Pond, West Lake, the West Lake drainage channel, Sandy Creek, the rubble pile, the South Property, and soils surrounding these areas were included in the studies. Areas where significant PCB residuals were detected were then characterized further to determine the volume and coordinates of the wastes. When volatile organics were discovered at the site, a work plan was also developed to determine the level and distribution of volatile organics. Work plans developed for soil and sediment sampling at the TRW site are provided in chronological order in Appendix 3.

d. Surface Water and Sediment Investigations

Sampling of surface water and sediments for PCBs and volatile organics was considered along with soil sampling in the work plans provided in Appendix 3. Potential receptors that might be affected by the migration of PCBs or volatile organics from the TRW site were generally identified through surveys of the local area and information on local water and land use that are available from various state and federal agencies. Potential receptors are discussed as part of the risk assessments for PCBs and volatile organics that were submitted to USEPA (Clement 1983a and 1984, respectively).

e. Air Investigation

Since PCBs have low vapor pressures and soil matrices at the site containing volatile organics have weathered for several years, the potential that significant airborne concentrations of these materials would emanate from the site was considered to be small. Accordingly, an air investigation has not been conducted.

Task 4. Remedial Investigations Analysis

The results of the two major field investigations (one for PCBs and the other for volatile organics) were used to characterize wastes at the site, evaluate the importance of potential migration pathways, assess potential health and environmental risks associated with the migration of PCBs and volatile organics, and develop a preliminary set of remedial alternatives to address the potential problems identified during the studies.

a. Data Analysis

Based on sampling and analyses conducted to determine the distribution of PCBs at the TRW site, five areas of significant contamination were identified. They are the swale, the wax ditch, the rubble pile, the South Pond, and a small area on the South Property. The locations of these areas were presented in Figure 3 of Section II. The volume and coordinates of the contaminated material were determined for each of these locations. The range and average concentration of PCBs in each of the materials found at these locations were also characterized. The results of this waste characterization are summarized in Table 1. As indicated in the table, the highest average concentrations of PCBs were found in the wax ditch (4,000 ppm), although a single sample of South Property soil exhibited a concentration of 33,000 ppm. It should be noted that all PCB-containing materials at the site are soil-type matrices, although the residue in the wax ditch is composed mostly of wax and therefore is 100% organic. Details of the characterization and distribution of wastes at the TRW site were provided in an earlier report (Clement 1983a).

Groundwater analyses from samples collected at the TRW site indicated that at present, the migration of PCBs has been relatively limited and, as expected, occurs extremely slowly. Significant concentrations of PCBs in groundwater have been detected consistently in only three wells immediately downgradient of the South Pond. The highest concentration recorded was 1 ppb, although typical concentrations in these wells averaged 150 ppt. Details of the groundwater monitoring program and information on local hydrogeology were provided in an earlier document (Clement 1983a).

TABLE 1

OVERVIEW OF RESIDUAL PCB CONCENTRATIONS AT THE TRW SITE

Region	Surface Area (ft^2)	Volume (ft^3)	Typical Concentrations (ppm)	Highest Level Found (ppm)	
South Pond sediment	7.0×10^4	7.5×10^4	300	2,000	Concentrations decrease with depth
Swale	7.5×10^4	(2.2×10^5)[a]	250	1,600	Concentrations decrease with depth (but there is contamination at 10 feet in some spots)
Wax ditch	3.0×10^3	7.5×10^3	4,000	5,000	Contamination concentrated in organic residue
Rubble pile	(2.3×10^4)[b]	(9.2×10^4)[b]	100	1,000	Area and composition are not well defined
South Property	(1.2×10^5)[c]	(1.3×10^4)[c]	<10[c]	33,000	Area and composition are not well defined

[a]Depth of soil containing residual PCBs depends heavily on concentrations considered. This volume is for soil suspected to contain to at least 50 ppm.

[b]Because the rubble pile is an amorphous conglomeration of material, it is poorly defined; the area and volume are thus estimates.

[c]Residual PCBs on the South Property are irregularly distributed. The volume and surface area represent estimates of the region where PCBs occur in concentrations greater than 50 ppm. In this case, typical and average concentrations do not correlate.

SOURCE: Clement Associates, Inc., June 20, 1983

A risk assessment was also conducted as part of this investigation (Clement 1983a). The potential PCB migration pathways considered include volatilization, surface runoff, and percolation to groundwater. The potential receptors identified for consideration varied from one pathway to another.

For volatilization, site workers and residential neighbors downwind of the site were considered. Minerva City well users, Sandy Creek users, and potential, small volume well users in the immediate vicinity of the plant were each considered in the case of groundwater percolation, and users of Sandy Creek, in the case of surface runoff. The results of the risk assessment indicate that the potential risks posed by the presence of PCBs at the Minerva site are minimal. Nevertheless, TRW undertook to develop a remedial action plan to reduce the potential risks due to the presence of PCBs to uniformly insignificant levels.

The results of the second field investigation, conducted to determine the distribution of volatile organics at the site, indicated that volatile organics were present in some of the same areas on the site where PCBs had been detected. They were not detected in swale soils, however. The principal volatile organic detected in these areas was TCA, although lower concentrations of TCE and traces of 1,1-dichloroethane, trans-1,2-dichloroethene, and tetrachloroethene were also detected. The range and average concentrations of TCA detected in specific areas at the TRW site are summarized in Table 2. Details of the results of this investigation were provided in an earlier report (Clement 1984).

TABLE 5

RESULTS OF A LEACHATE STUDY OF CONTAMINATED SOIL MATRICES FROM THE TRW SITE IN MINERVA, OHIO

	Native Material (ppm)			1st Extract (ppm)			2nd Extract (ppm)			3rd Extract (ppm)			4th Extract (ppm)		
Sample	PCB	TCA	TCE	PCB	TCA	TCE	PCB	TCA	TCE	PCB	TCA	TCE	PCB	TCA	TCE
Wax Ditch	<1.0	5,900	<1.0	0.014	160	<1.0	<0.01	130.0	<1.0						
Swale	610	<1.0	<1.0	3.0	<0.01	<0.01	5.3	<0.01	<0.010						
Duplicate				3.7	<0.01	<0.01									
Pond	1,900	43	170	5.3	7.7	28.0	4.6	<1.0	16						
Rubble Pile	840	730	60	0.25	27.0	1.6	0.21	18	1.0						
Duplicate							0.21	15	1.0						
Mix (9:4:4:1)	---	---	---	4.7	44	7.0	5.3	20	2.1						
Solidified Pond	---	---	---	0.27	0.12	0.82	0.051	0.096	0.58						
Duplicate	---	---	---	0.60	0.49	0.45	0.057	0.024	0.22						
Solidified Swale	---	---	---	0.015	<0.001	<0.001	0.011	<0.001	<0.001						
Duplicate	---	---	---	0.012	<0.001	<0.001	0.010	<0.001	<0.001						
Partially Solidified Mix	---	---	---	0.098	140	I	0.029	160	I	0.035	140	I	0.026	130	I
Duplicate	---	---	---	0.043	180	I	0.021	180	I	0.023	140	I	0.044	110	I

I = Not detected due to interference.

considered further below. The fact that the concentration of PCBs in the extract exceeds the solubility of Aroclor 1254 in water suggests that PCBs are not leaching in a dissolved phase but as a colloidal suspension. Fixing pond sediments appears to suppress formation of the colloidal particles, and sequential leaching appears to deplete the population of particles. It should be noted that formation of colloidal suspensions is not expected to represent an important process in the secure cell because the interred wastes will not be subjected to agitation. It should also be noted that colloidal particles would not be expected to penetrate the proposed clay barrier.

As expected, volatile organics are relatively mobile in a soil matrix environment (Clement 1984). Interestingly, however, the mobility of volatile organics is lower in soil matrices and higher in wax than predicted. In fact, the wax ditch residues are clearly responsible for the major contribution of leachate volatiles from the waste mix. Furthermore, fixing pond sediments or other matrices considerably reduces the mobility of volatiles.

Task 11. Detailed Analysis of Alternatives

The technologies identified that survived the preliminary screening, in which the reliability of the technology and its appropriateness for the TRW site were considered, all require excavation as an initial step. The evaluation of the alternatives was therefore divided into separable segments. First, the degree of excavation required to reduce risks and meet the objectives outlined in task 8 was evaluated to determine the volume of material that would have to be treated or disposed of. The details of this evaluation for PCBs and volatile organics have been presented in two previous documents (Clement 1983a and Clement 1984, respectively). Risk assessments performed to determine the required degree of excavation also addressed the question of whether capping would be required or if clean soil (treated or new) would be sufficient to fill the excavated areas (Clement 1983a).

risk assessments

It should be noted that the South Pond requires additional consideration because water in the pond will have to be removed and the sediments will have to be solidified. The pond water problem is being addressed through an application for a National Pollutant Discharge Elimination System (NPDES) permit to OEPA. Pond solidification was investigated in a laboratory study to ascertain its effectiveness in immobilizing contaminants and to establish the volume change that would accompany fixation.

The second step in the remedial alternative evaluation involved comparing treatment (solvent or detergent extraction), on-site interment, and off-site interment. As part of this evaluation, laboratory studies were developed to derive the additional data necessary to determine the applicability and effectiveness of the alternatives considered (see task 10). Each of the alternatives is described below.

Soil purification by solvent extraction is a new and undemonstrated process; however, it is based on well-evaluated existing processes. The technique consists of a soil-solvent contact system, a soil drying system, a solvent recovery system, and a soil conveying system. The solvent-extraction unit treats excavated contaminated soil by bringing it into contact with a solvent. Five solvents were tested to determine their suitability: methanol, methyl chloride, TCE, toluene, and methyl ethyl ketone (MEK). The tests concluded that solvent extraction was feasible. The results are provided under task 10. However, the introduction of these solvents presents an additional risk of environmental contamination owing to their toxicity, which makes solvent extraction a less viable remedial alternative. Another important consideration addressed in the development of the solvent extraction alternative was that though the engineering of most of the major components had been developed, applying the technique to the problem at the TRW site poses unique problems and would require substantial development work. Primarily because of these last two complications, and coupled with a preliminary cost estimate that indicated a proven technology (on-site interment) was cost competitive, solvent extraction was dropped from further consideration.

Both off-site and on-site disposal in secure landfills are widely practiced procedures and therefore pose no problems with respect to technical reliability. Off-site disposal of contaminated soils involves excavation and loading of the soils, transportation (an estimated 250 miles), disposal costs, backfilling, capping, grading, and other site work. This alternative also includes the dredging and fixation with kiln dust of the pond sediments. The remedial alternative of on-site interment has been described in previous reports (Clement 1983a,b). It consists of constructing a secure interment cell with a clay liner. Modifications to the proposed plan, as discussed under task 13, include the addition of a synthetic liner. The cell would receive excavated materials from the five areas containing residual PCBs (several of which also contain residual volatile organics).

On-site and off-site interment were compared in terms of both the risks they pose and their cost. Assuming adequate construction of a secure cell, the risks posed by potential migration from an on-site or an off-site secure cell should be approximately comparable. Off-site interment has an added component of risk, however, due to the probability that an accident will occur during transport of the wastes. A transportation risk assessment was therefore performed for the off-site disposal alternative. It was concluded that there is a substantial risk of a traffic death occurring as a result of off-site transportation of materials. In addition, the need for a transportation plan, manifesting, and a review of final disposal sites makes off-site disposal a more difficult alternative to implement than on-site interment. Cost figures

Task 12. Evaluation and Selection of Cost-Effective Alternatives

The two remaining remedial alternatives that survived the initial screenings are

- a combination of excavation and capping with on-site interment.
- a combination of excavation and capping with off-site interment.

Based primarily on the calculated relative risks (off-site interment is subject to transportation risks) it appears that the first alternative (on-site interment) is superior. In addition, the advantages of on-site interment increase when costs are considered in the comparison.

Task 13. Conceptual Design

Based on the analysis presented in the previous sections, the best remedial alternative was determined to be a combination of excavation and capping with on-site interment in a secure cell.[1] A conceptual design for this remedial alternative has been presented in a previous report (OBG 1983). That report addressed the suitability of local soils as liner materials, the required areas and depths of excavations, landfill design details, operations during construction, and long-term monitoring and maintenance.

The conceptual design was modified in November 1984 as a result of the need to account for a remedial response to volatile organic contamination and other developments. These modifications are described in detail in Appendix 1 of this report and are summarized below:

---

[1] South Pond sediment will be solidified before interment, and South Pond water will be treated via activated carbon filtration and discharged to the creek.

1. The landfill design volume was increased from 12,000 to 15,000 cubic yards to account for additional material that will be excavated from the rubble pile.

2. The landfill location was adjusted to avoid conflict with a contaminated area to be excavated.

3. The landfill side slopes were decreased to take advantage of additional available land recently purchased by TRW.

4. A synthetic liner was added to the landfill design to compensate for the lack of a 50-foot separation between the landfill and the seasonal high groundwater table.

5. The gravel leachate drainage system was modified to handle peak storm water flows during construction as well as the expected volumes of leachate.

6. The landfill construction will be a single-stage operation rather than the two-stage operation that was required when part of the landfill was going to be located over the contaminated area.

<u>Task 14. Final Report</u>

This report, and an accompanying set of permit applications (which will be provided in early December), constitute the final report for the feasibility study to support surface remediation at the TRW site.

<u>Task 15. Additional Requirements</u>

Deliverables listed under this section have already been provided in the earlier reports referenced throughout this report.

TABLE 2

OVERVIEW OF RESIDUAL TCA CONCENTRATIONS AT THE TRW SITE[a]

Region	Surface Area (ft^2)	Volume (ft^3)	Typical Concentrations (ppm)	Highest Level Found (ppm)	
South Pond sediment	7.0×10^4	7.5×10^4	17	90	Concentrations decrease with depth
Swale	7.5×10^4	2.2×10^5	<1	<1	No volatile organics detected
Wax ditch	3.0×10^3	7.5×10^3	14,600	180,000	Concentrations highest at 1 and 2 feet depths
Rubble pile	2.3×10^4	9.2×10^4	5[b]	24[b]	Low overall concentrations except for a single core sample
South Property	1.2×10^5	1.3×10^4	NA[c]	NA[c]	----

[a]TCA is the principal volatile organic detected at the TRW site. Concentrations of several volatile organics were also detected but at much lower concentrations.

[b]The values in the table reflect the numbers derived without the single hot-spot being included in the data. Including the hot-spot, the average concentration is 1,000 and the highest concentration is 20,000.

[c]South Property soils were not analyzed because volatile organics cannot generally be detected in surface soils and therefore are not expected on the South Property.

Groundwater analyses for volatile organics from samples collected at the TRW site indicated that unlike PCBs, significant concentrations of volatile organics had migrated into the local groundwater. The major volatiles detected include TCE, trans-1,2-dichloroethene, and 1,1-dichloroethane, although lower concentrations of six additional volatiles were also detected. The results of the groundwater analyses for volatile organics are presented in Table 3. Well locations for wells presented in Table 3 are provided in Figure 2 of Section II. Details of the volatile organic groundwater monitoring program and local hydrology are provided in an earlier report (Clement 1984).

A risk assessment conducted to determine the potential health impact of volatile organics present in the soils and groundwater at the TRW site indicated that a significant, future potential health risk might be associated with the volatile organics already present in groundwater, as well as with the residual volatiles present in soils and sediments at the site (Clement 1984). Because of this finding, TRW undertook to develop a remedial plan to address this problem.

b. Application of Preliminary Technologies

An initial evaluation of the objectives of the remedial alternatives applicable at the TRW site indicated that

- Additional information would be required to design and evaluate remedial alternatives for the site adequately.
- Surface remediation at the site could be designed to address both PCBs and volatile organics simultaneously.

TABLE 3

RESULTS OF VOLATILE ORGANIC ANALYSIS OF GROUNDWATER SAMPLES FROM THE TRW SITE, MINERVA, OHIO[1]
(Concentrations in μg/liter)

Compound	Well No. 1 Sampling Date a	b	c	d[2]	Well No. 2 Sampling Date a	b	c	d	Well No. 8 Sampling Date a	b	c	d	Well No. 9 Sampling Date a	b	c	d
1,1,1-Trichloroethane	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	30	26	18
1,1-Dichloroethane	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	22	17	17
1,2-Dichloroethane	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
Chloroethane	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
Trichloroethene	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
1,1-Dichloroethene	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
Trans-1,2-dichloro-ethene	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
Chloroethene	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-
2-Propanone	NS	-	-	-	-	-	NS	NS	NS	-	NS	NS	NS	-	-	-

Compound	Well No. 10 Sampling Date a	b[3]	c[3]	d[2,3,4]	Well No. 11 Sampling Date a	b	c	d	Well No. 12 Sampling Date a	b	c	d[2]
1,1,1-Trichloroethane	-	11	-	-	NS	-	-	-	-	-	-	-
1,1-Dichloroethane	47	200	260	290	NS	26	63	71	-	-	T	-
1,2-Dichloroethane	-	-	-	-	NS	-	-	-	-	-	-	-
Chloroethane	-	-	-		NS	-	-	-	-	-	-	-
Trichloroethene	39	120	100	140	NS	12	18	23	-	-	-	-
1,1-Dichloroethene	-	-	-	18	NS	-	-	-	-	-	-	T[3]
Trans-1,2-dichloro-ethene	120	320	350	500	NS	45	96	150	-	10	114	T[3]
Chloroethene	-	-	-	-	NS	-	26	-	-	-	-	-
2-Propanone	-	-	-	-	NS	T	49	-	-	-	-	-

[1]Although a complete volatile organic scan was performed on all samples listed, only positive results are presented in this table. Compounds normally reported in a volatile organic scan but not listed in this table were not detected.

[2]Butyl acetate was detected in addition to the listed chemicals. In well 12 the concentration of butyl acetate was sufficient to interfere with other analyses, resulting in a detection limit of 500 ppb.

[3]Because of the concentrations of volatile organics detected in well 10, the limit of detection had to be raised to 50 ppb.

[4]In addition to the listed chemicals, tetrachloroethene was found at 48 ppb.

KEY:
- = Compound not detected
T = Trace compound detected at concentration below the stated 10 ppb detection limit
NS = Well not sampled on date indicated

Sampling dates: a=June 1, 1984; b=June 12, 1984; c=June 28, 1984; d=July 12, 1984

TABLE 3, Continued

No. 21	Well No. 13				Well No. 14				Well No. 18				Well No. 19				Well No. 20				Well			
	Sampling Date				Sampling Date				Sampling Date				Sampling Date				Sampling Date				Sampling Date			
Compound	a	b	c	d[2]	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d[2]
1,1,1-Trichloroethane	-	NS	12	T	-	NS	-	T	NS	T	-	-	-	T	-	-	NS	-	-	-	NS	-	-	-
1,1-Dichloroethane	-	NS	530	330	-	NS	-	-	NS	108	120	92	12	1,500	1,200	1,300	NS	-	-	-	NS	T	-	-
1,2-Dichloroethane	-	NS	-	-	-	NS	-	-	NS	T	-	-	-	10	-	-	NS	T	T	12	NS	T	-	-
Chloroethane	-	NS	58	43	-	NS	-	-	NS	110	250	270	-	-	-	-	NS	-	-	45	NS	-	-	-
Trichloroethene	-	NS	18	T	-	NS	15	11	NS	T	-	-	13	1,300	1,300	1,200	NS	-	-	-	NS	T	-	-
1,1-Dichloroethene	-	NS	-	-	-	NS	-	-	NS	-	-	-	-	25	-	16	NS	-	-	-	NS	T	-	-
Trans-1,2-dichloro-ethene	-	NS	120	-	30	NS	14	18	NS	11	-	12	32	910	690	1,300	NS	15	12	27	NS	45	T	18
Chloroethane	-	NS	-	-	-	NS	-	-	NS	-	-	-	-	91	-	110	NS	-	-	-	NS	-	-	-
2-Propanone	X	NS	-	-	-	NS	-	-	NS	-	-	-	-	-	-	-	NS	-	-	-	NS	-	-	-

SOURCE: Clement Associates, Inc., August 27, 1984

- Remedial alternatives for groundwater treatment would have to be considered to address the problems posed by volatile organics already present in groundwater.
- The groundwater and surface remediation questions could be handled separately for expediency.

Details concerning these findings were presented earlier (Clement 1984).

Task 5. <u>Final Remedial Investigation Report</u>

The results of each phase of the field investigations conducted at the TRW site in Minerva, Ohio, (including field sampling and analysis, data evaluation, assessment of risk, and recommendations for remediation) have been documented in the several reports already submitted to USEPA and OEPA. The contents of these reports were referenced under Tasks 3 and 4 of this section, where appropriate.

Task 6. <u>Additional Requirements</u>

Of the additional requirements outlined in the GSOW, chain-of-custody procedures and quality assurance/quality control considerations were both incorporated into the work plans for the TRW site.

a. <u>Reporting Requirements</u>

Since remedial investigations at the site have now been completed, the question of monthly progress reports is moot.

b. <u>Chain-of-Custody</u>

Appropriate chain-of-custody protocols were outlined in all of the work plans developed for the TRW site (see Appendices 2 and 3). The custody of samples collected at the site was properly documented from collection through analysis.

c. Quality Assurance/Quality Control (QA/QC)

Quality assurance/quality control requirements were considered during all phases of the TRW site investigation for both laboratory and field work. Field QA/QC procedures relied heavily on the proven performance of adopted protocols. Sample collection, handling, storage, transport and analysis protocols that were recommended by USEPA, OEPA, or other government agencies were used when appropriate. If procedures were required for which established protocols could not be adopted, procedures with reported track records in the literature were preferred to the development of new procedures.

All procedures were specified in detail to insure smooth communication and coordination between Clement Associates and the sampling team (usually from Alert Laboratories). The representativeness, integrity, and reproducibility of field practices were monitored through a combination of field blanks, duplicates, and more importantly, analyses of the pattern of results over a large number of samples from a given area. Strict chain-of-custody procedures were followed during the transport and handling of all samples.

QA/QC for laboratory procedures was also maintained with the analysis of a series of lab blanks, duplicates, and spikes. Sampling work plans specified the specific analyses to be performed, established protocols to be used in the analyses, and identified the desired limits of detection for each batch of samples collected for analysis. The procedures for calibration, the frequency of QC checks, the protocols used in analysis and sample handling, and the general QA/QC management philosophy of the chosen laboratory are summarized in Appendix 4.

IV. THE FEASIBILITY STUDY

As mentioned in Section III, the feasibility studies required for this site were divided into two independent projects: one to support surface remediation at the site and one to support groundwater remediation. The feasibility study to support surface remediation has been completed, and the results are presented in this section. The feasibility study to support groundwater remediation is still in progress and will be completed early next year. (tent. date?)

This section of the report will serve to document the development, screening, and selection of surface remediation alternatives, which have already been completed (and have been partially documented in previous reports), as well as to report the results of the recently completed surface remediation feasibility study. Modifications to the surface remediation plan submitted to USEPA and OEPA in December 1983 are also presented. These modifications were necessitated by the discovery of volatile organics and the results of the completed surface remediation feasibility study.

Task 7. Description of Current Situation

The current situation is detailed in Section II of this report.

Task 8. Development of Alternatives

The risk assessment performed to determine the potential health and environmental effects of PCB-contaminated soils at the TRW site (Clement 1983a) concluded that the potential effects were not significant but that the margins of safety developed in the risk assessment varied depending on the source of contamination and the transport mechanism considered. Based on these conclusions, TRW decided to evaluate remedial alternatives that would reduce all risks to uniformly insignificant levels. When volatile organics were discovered at the site in early 1984, TRW sought to modify the remedial action plan originally developed for the PCB problem in a manner that would reduce the potential risks from volatile organics to the same insignificant level (Clement 1984).

a. Remedial Response Objectives for Surface Remediation

The objectives of the remedial response program, as stated in previously submitted reports, are to mitigate the potential for PCB migration further and decrease the potential exposures calculated for each receptor population in the risk assessment. The remedial investigation identified three receptors of major concern: (1) users of small private wells in the immediate vicinity of the property, (2) users of Sandy Creek and neighboring properties that may become contaminated via surface runoff, and (3) on-site workers. It should be noted that all potential exposures considered would not occur for at least 100 years, if at all.

The primary technical objectives identified in order to mitigate potential PCB migration are to prevent further surface runoff and minimize potential percolation to groundwater.

The specific requirements varied with the location of residual PCBs (Clement 1983a).

The objectives identified to deal with the migration of volatile organics from the site are to mitigate the potential exposure of users of small private wells in the area and of future users of the Minerva well. The primary technical objective identified to mitigate volatile organic migration based on the above exposure considerations is to minimize percolation to groundwater (Clement 1984).

The remedial response to the PCB problem focuses primarily on source control, i.e., surface remediation. The volatile organics problem is associated with both source control (surface remediation) and off-site remedial action (groundwater remediation). The groundwater remediation plan will be finalized early next year. However, it was determined that surface remediation of volatile organics could be effectively addressed together with surface remediation of PCBs because most of the volatile organics at the site occur at the same locations as the PCBs.

b. Identification of Remedial Technologies

Based on the technical objectives outlined above, a series of appropriate remedial technologies were identified for surface remediation of PCB and volatile organic contamination. Contaminants may be (1) immobilized in place so that no further off-site migration occurs, (2) treated so that contaminants are converted into nontoxic compounds, or (3) removed from the

confirmation

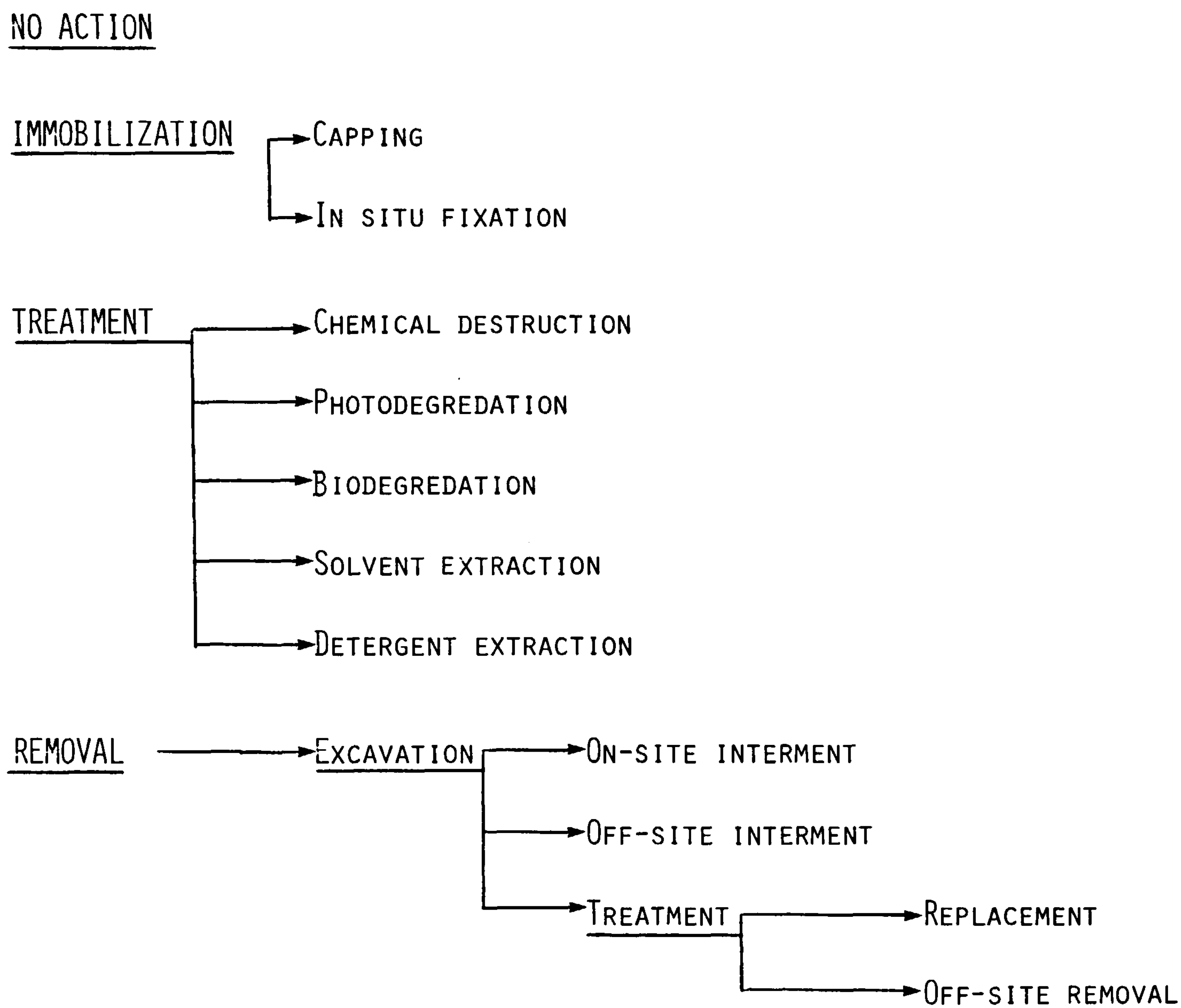
areas of contamination. If removal is chosen, then a final disposal or destruction technology must also be considered. The possibilities include disposal in a secure cell on site, disposal in a secure cell off site, or excavation and treatment. The technologies identified for further consideration as part of this project are outlined in Figure 4.

Some of the remedial technologies considered were eliminated in a preliminary screening because of their inappropriateness for the TRW site or their technological reliability. The "no action" alternative was rejected as a remedial alternative since it would not meet the objective of increasing the margins of safety, as calculated in the risk assessment.[1] Biodegradation, involving the destruction of PCBs by special microorganisms, is still in a developmental stage, and it cannot be considered a reliable technology. Some chemical destruction processes, such as the use of sodium salts of polyethylene glycol, have been used to remove PCBs from liquids (i.e., transformer oils), but they are considered unproven technologies for soils and were therefore eliminated as possible remedial technologies. Similarly, photodegradation, which involves solar irradiation in the presence of a hydrogen donor such as a light hydrocarbon oil, is only appropriate where little soil penetration has occurred; it was therefore eliminated

[1]The "no action" alternative is retained for consideration in this report in order to provide a baseline for comparing the effectiveness of other technologies in reducing the risks associated with the present situation.

FIGURE 4

REMEDIAL ALTERNATIVE FLOW CHART FOR THE TRW SITE IN MINERVA, OHIO



as a possible technology. In addition, in situ solvent or or detergent extraction is an unproven technology and was therefore eliminated from further consideration.

c. Identification of Remedial Alternatives

After the preliminary screening of remedial technologies, the following site-specific remedial alternatives were developed:

1. No action
2. Capping
3. Excavation and on-site interment
4. Excavation and off-site interment
5. On-site fixation
6. Excavation and solvent/detergent extraction with soil replacement
7. A combination of several of the above

Each of these alternatives was developed to varying degrees until, due to either its inappropriateness or an inferior cost/benefit valuation, it was eliminated from further consideration. The following alternatives were considered in the greatest detail:

- No action
- Excavation with solvent/detergent extraction and soil replacement
- A combination of excavation and capping with on-site interment
- A combination of excavation and capping with off-site interment

Postclosure maintenance and monitoring requirements were considered for these last three alternatives. Treatment and disposal of South Pond water and the fixation of pond sediments prior to interment were also taken into account. Details of the development and evaluation of the alternatives listed are provided below.

Task 9. Initial Screening of Remedial Alternatives

The remedial alternatives were screened, as outlined in task 8.

Task 10. Laboratory Studies

Laboratory studies were conducted during two phases of this investigation. During the initial development of remedial alternatives, a solvent extraction study was performed to evaluate the efficiency of this process. In order to engineer the design of the proposed secure cell and effectively immobilize the wastes to be placed in it, a leachate study was also performed to quantify the mobility of PCBs and volatile organics in the wastes.

The results of the earlier solvent extraction study are provided in Table 4. This table provides information on the concentration of PCBs in the initial soil sample, the residual concentration of PCBs in the soil following extraction, the quantity of PCBs extracted, the concentration of PCBs in the extract, and the calculated partition coefficient between soil and solvent. The most striking conclusion to be drawn from the data is that the efficiency with which each of the solvents--

TABLE 4

RESULTS OF LABORATORY EXTRACTION THERMODYNAMIC STUDY

Solvent	Weight of Soil[a] (g)	Initial Amount of PCB in Soil ($x10^{-3}$g)	Concentration of PCB in Extract[b] (ppm)	Total Amount of PCB Extracted[b] ($x10^{-3}$g)	Measured Residual Concentration in the Soil (ppm)	Calculated Residual Concentration in the Soil[c] (ppm)	Effective Partition Coefficient (soil/solvent)
CH_2Cl_2	5.1858	1.62	22.4	1.46	10	31	0.45
CH_3OH	4.4179	1.38	36.17	1.43	31	-11	0.86
	4.6307	1.44	35.40	1.40	33	9	0.93
	4.2245	1.32	35.87	1.42	21	-125	0.58
CL_2C-CHCL	4.7267	1.47	8.4	0.63	7	177	0.83
	4.6842	1.46	10.59	0.79	8	142	0.76
	4.4981	1.40	16.19	1.21	10	42	0.59
$(CH_3)_2CO$	5.2886	1.65	44.13	1.74	33	-17	0.74
	5.0310	1.57	48.34	1.91	17	-68	0.35
	4.6084	1.44	37.37	1.48	13	-9	0.35
$C_6H_5CH_3$	5.0958	1.59	42.99	1.83	16	-12	0.37
	4.9877	1.56	39.91	1.74	9	-36	0.22
	4.9337	1.54	45.20	1.97	11	-87	0.24

[a]Contaminated soil from site was dried and sieved. Soil was analyzed for PCBs and determined to contain 312 ppm. Aliquots of soil were extracted for 7 days with 50 ml of solvent.

[b]Correction made for loss of solvent during extraction.

[c]Value obtained by subtracting the quantity of PCBs extracted from the total quantity in the initial soil sample.

methylene chloride, methanol, TCE, methyl ethyl ketone, and toluene--extracts PCBs is roughly equivalent. Thus, if solvent extraction were to be attempted, the choice of a solvent can be based on other criteria such as their volatility or toxicity.

The results of the soil leachate study are summarized in Table 5. The protocols used in this study were presented in "Proposed Feasibility Study to Support Surface Remediation at the TRW Site in Minerva, Ohio" that was provided to USEPA and OEPA under separate cover. Briefly, a fixed quantity of each of the four major wastes present at the site (pond sediment, swale soil, wax ditch residues, and rubble pile soils) was mixed with a large volume of laboratory water and agitated for 24 hours. The supernatant was then analyzed for PCBs, TCA, and TCE. The process was then repeated on the same soil sample at least twice. Note that a fifth mixture composed of a weighted combination of the other wastes (representative of the expected composition of the final secure cell material) and additional samples containing fixed pond sediments were also extracted and analyzed.

The results indicate that PCBs are slightly more mobile and volatile organics slightly less mobile than would be expected on theoretical grounds (see Clement 1983a and 1984). With two exceptions, however, overall agreement between theory and experiment is excellent. The two exceptions are the apparent presence of colloidal PCBs and the apparent mobility of volatile organics in waxes detected in the leachate study. These are

APPENDIX 1

Modifications to the Proposed Excavation and
Secure Cell Construction for Surface Remediation
at the TRW Site*

* Addendum to Appendix D of "Enclosures to Letter of December 20, 1983 from Mr. William R. Phillips (TRW) to Mr. Basil G. Constantelos (USEPA)" prepared for TRW, Inc., by Clement Associates, December 20, 1983

PRELIMINARY ENGINEERING DESIGN

MINERVA, OHIO SITE

TRW, INC.

AIRCRAFT COMPONENTS GROUP

NOVEMBER 9, 1984

(AMENDS DECEMBER 20, 1983 SUBMITTAL)

O'BRIEN & GERE ENGINEERS, INC.
1304 BUCKLEY ROAD
SYRACUSE, NEW YORK 13221

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5 Leachate Collection System and Miscellaneous Details
6 Cap Water Balance
7 Secure Landfill Perspective View
8 Construction Operations Sequencing Plan (Critical Path)

SECTION 1 - INTRODUCTION

1.01 Background

On December 20, 1983, O'Brien & Gere Engineers, Inc. published a report entitled "Preliminary Engineering Design" for TRW, Inc. That report (and accompanying drawings) provided a basis for design, construction operating plan and monitoring and maintenance program for a proposed secure landfill at TRW's Minerva, Ohio site. The landfill was designed to hold soil and solidified pond sediments containing residual concentrations of polychlorinated biphenyls (PCBs).

1.02 Scope

This report shall serve to amend the December 20, 1983 report to reflect modifications to the original design concept. These modifications include:

1. Increasing the size of the landfill to contain an additional 3,000 cubic yards of contaminated material.
2. Adjusting the landfill location to avoid conflict with a contaminated area scheduled to be excavated.
3. Decreasing the landfill side slopes to maximum of 1:4.
4. Adding a synthetic membrane liner above the proposed compacted clay liner.

The accompanying drawings supersede those submitted with the previous report.

SECTION 2 - LANDFILL DESIGN

2.01 Landfill Design Volume

Clement Associates had previously estimated that the landfill volume required to contain the contaminated soils and pond sediments would be 10,000 cubic yards. As described in the December, 1983 report, it was estimated that excavation of the temporary haul roads and construction zone surfaces would generate an additional 2,000 cubic yards of material. Therefore, it was determined that the total required volume of the landfill was 12,000 cubic yards.

The estimated volume of contaminated material to be placed within the landfill has been revised by Clement Associates to 13,000 cubic yards, based on the need to excavate additional areas of contamination. Including the additional 2,000 cubic yards resulting from construction activities gives a revised landfill design volume of 15,000 cubic yards.

2.02 Landfill Location

In April, 1984, TRW acquired an approximate 12.8 acre parcel of land, the former Unkefer property, immediately east of its Minerva plant site. This property is shown on Figure 1. The purchase of this land provides additional area for constructing the proposed secure landfill, and allows two modifications to the previous design:

1. Due to space limitations, the December, 1983 design showed a portion of the landfill to be located over the contaminated drainage swale. With the additional area available, the landfill will be located east of the swale (as shown on Figure 3A) to avoid the conflict, simplifying the construction procedure.

2. The landfill will be configured in a more economical square shape instead of the oval configuration which was previously proposed. Using a square orientation, a 15,000 cubic yard landfill can be built using about the same volume of clay material as would have been required to build an oval shaped, 12,000 cubic yard landfill.

The revised landfill location and configuration are shown on Figure 3A, and a cross section through the proposed landfill is shown on Figure 4. Details of the landfill construction, including site preparation, soil liner, berms and leachate collection system, are as described in the December, 1983 report.

2.03 Final Cap

The previous design called for side slopes of 1:3 for the final cap. It was necessary to use the 1:3 slope to keep the landfill within the available area. Although it is technically feasible to build the landfill with that slope, the purchase of the former Unkefer property provides sufficient additional area so that a 1:4 slope can be used. The use of the slightly flatter slope (see Figure 4) will make it easier (and therefore less expensive) to construct the compacted clay cap and to perform maintenance on the completed landfill.

On Page 3-12 of the December, 1983 report it was stated that "the final clay cap thickness will be 3-1/2 feet". It should be clarified that proposed capping system includes 3 feet of compacted clay with a 6-inch topsoil cover.

Although the landfill design volume will be increased by about 25 percent, its surface area (and rate of stormwater runoff) will be roughly equal to that proposed in December, 1983. Therefore, the discussion of the proposed surface water drainage system (Section 3.08 of the December, 1983 report) is still applicable.

Similarly, the calculation of the cap water balance (Section 5.04) was conservatively based on a grade of 7 percent. Therefore, the decrease of the side slopes from 33 percent to 25 percent will not affect that calculation.

2.04 Liner System

It is currently proposed to construct the landfill with a synthetic membrane liner in addition to the 3-foot compacted clay soil liner. The additional liner results in a very conservative design, and compensates for the lack of a 50-foot separation between the landfill and maximum high groundwater table, as required by TSCA regulations, 40 CFR 761.75 (b)(3).

The proposed liner will be fabricated from high-density polyethylene (HDPE) with a nominal 60-mil thickness. This material has been tentatively selected on the basis of:

1. chemical resistance to the material to be landfilled (PCB soils),
2. resistance to puncture and tear during installation, and
3. availability of wide material stock, limiting the number of seams required.

Immediately after installation, the liner will be covered with a minimum 6-inch layer of clean sand to protect from damage due to subsequent construction operations.

2.05 Leachate Collection

The leachate collection system design has been modified to reduce the thickness of the gravel drainage layer from 12 inches to 6 inches. The drainage layer will be placed above the sand cushion, and will have a layer of filter fabric above and below to exclude fine material which could clog the gravel. The drainage layer, sloped at 1 percent, will discharge to a perforated collection pipe leading to a leachate storage tank. Details of the proposed system are shown on Figure 4.

The modified drainage layer will be capable of handling expected leachate volumes as well as peak stormwater flows which may be generated during construction prior to placement of temporary cover or the final cap.

2.06 Remedial Program

On Page 3-14 of the December, 1983 report, under the discussion of remediation of the Drainage Swale (Section A), it is mentioned that a portion of the landfill will be constructed over part of the swale. As described above, the proposed landfill location has been revised to avoid that conflict, so the discussion is no longer applicable. Similarly, on Page 4-7 of the December, 1983 report, the discussion regarding a two-stage construction of the landfill no longer applies. Instead, per the revised design, the entire soil liner system, berms, and leachate collection system will be installed in a single operation.

The December, 1983 report described (on Page 3-15) the proposed excavation of a portion of the existing rubble pile to a depth of 1 foot. Clement Associates has defined an additional pocket of contamination with the rubble pile, which will be removed by excavation of a 100 foot diameter circular area to a depth of 5 feet. The excavated material will be placed within the secure landfill, and the excavation will be backfilled to grade as shown on Figure 3B.

SDMS US EPA REGION V
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IMAGERY INSERT FORM

The item(s) listed below are not available in SDMS. In order to view original document or document pages, contact the Superfund Records Center.

SITE NAME	TRW INC		
DOC ID #	118506		
DESCRIPTION OF ITEM(S)	MAPS		
REASON WHY UNSCANNABLE	___ILLEGIBLE	OR	X FORMAT(oversized)
DATE OF ITEM(S)	UNDATED, 1984		
NO. OF ITEMS	10		
PHASE	REM		
PRP			
PHASE (AR DOCUMENTS ONLY)	___ Remedial ___ Removal ___ Deletion Docket ___ Original ___ Update # ___ Volume ___ of ___		
O.U.			
LOCATION	Box # 1 Folder # 8 Subsection K8		

COMMENTS

GENERAL DRILLING SPECIFICATIONS
FOR MONITORING WELL

January 5, 1981

Lowenbach and Schlesinger Engineering
A Division of Clement Associates

DRILLING METHOD

Monitoring wells shall be drilled by the cable tool method. In unstable unconsolidated formations the hole shall be advanced by driving the casing and bailing, and no sample shall be taken except when the casing has been driven ahead of the bottom of the hole; in stable unconsolidated formations, samples shall be taken by drilling three (3) feet and bailing before or after driving the casing to the bottom of the drilled material. In consolidated formations, the hole is advanced by drilling and samples taken by bailing. Casing may be run later to insure that the hole does not cave. The CONTRACTOR shall be responsible for designing, controlling, and carrying out a drilling program that conforms to sampling method requirements given below.

DRILLER'S LOGS AND REPORTS

During the drilling of monitoring wells the CONTRACTOR shall prepare and keep a complete log setting forth the following:

- The reference point for all depth measurements
- The depth at which each change of formation occurs
- The depth at which the first water was encountered
- The depth at which each stratum was encountered
- The thickness of each stratum
- The identificaiton of the material of which each stratum is composed such as:
    - Clay
    - Sand or silt

- Sand and gravel - Indicate whether gravel is lose, tight, angular or smooth; color
- Cemented formation - Indicate whether grains (if present) have natural cementing material between them; e.g. silica, calcite, etc.
- Hard rock - Indicate whether sedimentary bedrock, or igneous rock (granite-like, basalt-like, etc.)

- The depth interval from which the formation sample was taken
- The depth to static water level (SWL) and changes in SWL with well depth
- Total depth of completed well
- The depth of the surface seal
- The nominal hole diameter of the well base above and below the casing seal
- The amount of cement (number of sacks) installed for the seal
- The depth and description of the well casing
- The description (to include length, diameter, slot size, material and manufacturer) and location of well screen and screen envelope (filter)
- The depth and description of the bentonite seal

FORMATION SAMPLING INTERVAL, HANDLING AND IDENTIFICATION

Formation samples are to be taken at three (3) foot intervals, and at any pronounced change of the formation.

One (1) 100 in^3 representative sample shall be obtained from each sampling interval. Immediately after retrieval formation samples shall be placed in approved containers, securely closed to avoid spillage and contamination and clearly labeled with the following information:

- Location of the well
- Name or number of the well
- Depth interval represented by the sample
- Date taken
- Time taken

Formation samples, immediately after being placed in container, shall be labeled clearly, either directly on the container or on a tag attached thereto, using ink, indelible pencil or other medium that is resistant to moisture and sunlight. The label shall not be readily removable from the container. The CONTRACTOR shall be responsible for the safe storage of formation samples until such time as they are accepted by CLEMENT ASSOCIATES, INC.

METHOD OF CONSTRUCTION

The CONTRACTOR shall use the cable tool (percussion) method for drilling the monitoring wells.

CASING SELECTION

All well casing shall be new. They shall be made of steel which conforms to ASTM specifications. The casing shall be of three (3) inch diameter. Length of casing will vary and will depend on which SWL is encountered.

Casing lengths shall be joined watertightly by a method appropriate to the material used so that the resulting joint shall have the same structural integrity of the casing itself. A threaded joint is the preferred method.

WELL GROUTING

Where specified a concrete grout shall be used. The grout shall consist of a mixture of Portland cement (ASTM C150), sand, course aggregate and water in the proportion of at least five (5) bags of cement per cubic yard of concrete to not more than six (6) gallons of clean water per bag of cement. The use of special cements, bentonite to reduce shrinkage or other admixtures to reduce permeability, increase fluidity and/or control time of set and the composition of the resultant slurry must be approved by CLEMENT ASSOCIATES, INC.

Bentonite grout shall be placed in accordance with the enclosed drawings.

Methods of installation of bentonite grout and concrete grout shall be approved by CLEMENT ASSOCIATES, INC.

SCREEN AND FILTER MATERIAL

A continious three (3) inch diameter slot wire wound stainless steel screen (20 slot), five (5) foot length shall be used and installed according to the method deemed appropriate by the CONTRACTOR. The screen shall be placed in accordance with the enclosed drawing.

The bottom of the screen shall be capped with appropriate cap or plug. The screen shall be joined to the casing by a method deemed appropriate by the CONTRACTOR.

Filter material shall consist of Ottawa sand or similar material and be placed according to the method deemed appropriate by the CONTRACTOR and approved by CLEMENT ASSOCIATES, INC. Location depth and width of filter shall be in accordance with the enclosed drawings.

WELL DEVELOPMENT

Each monitoring well shall be developed according to the method deemed appropriate by the CONTRACTOR and approved by CLEMENT ASSOCIATES, INC.

SPECIAL CONSIDERATION

Only clean, noncirculating water shall be used as wash water for drilling. All drilling equipment, casing, weights, samplers, augers shall be cleaned prior to drilling the first hole and when drilling equipment is moved to a new well location.

The cleaning process shall consist of:

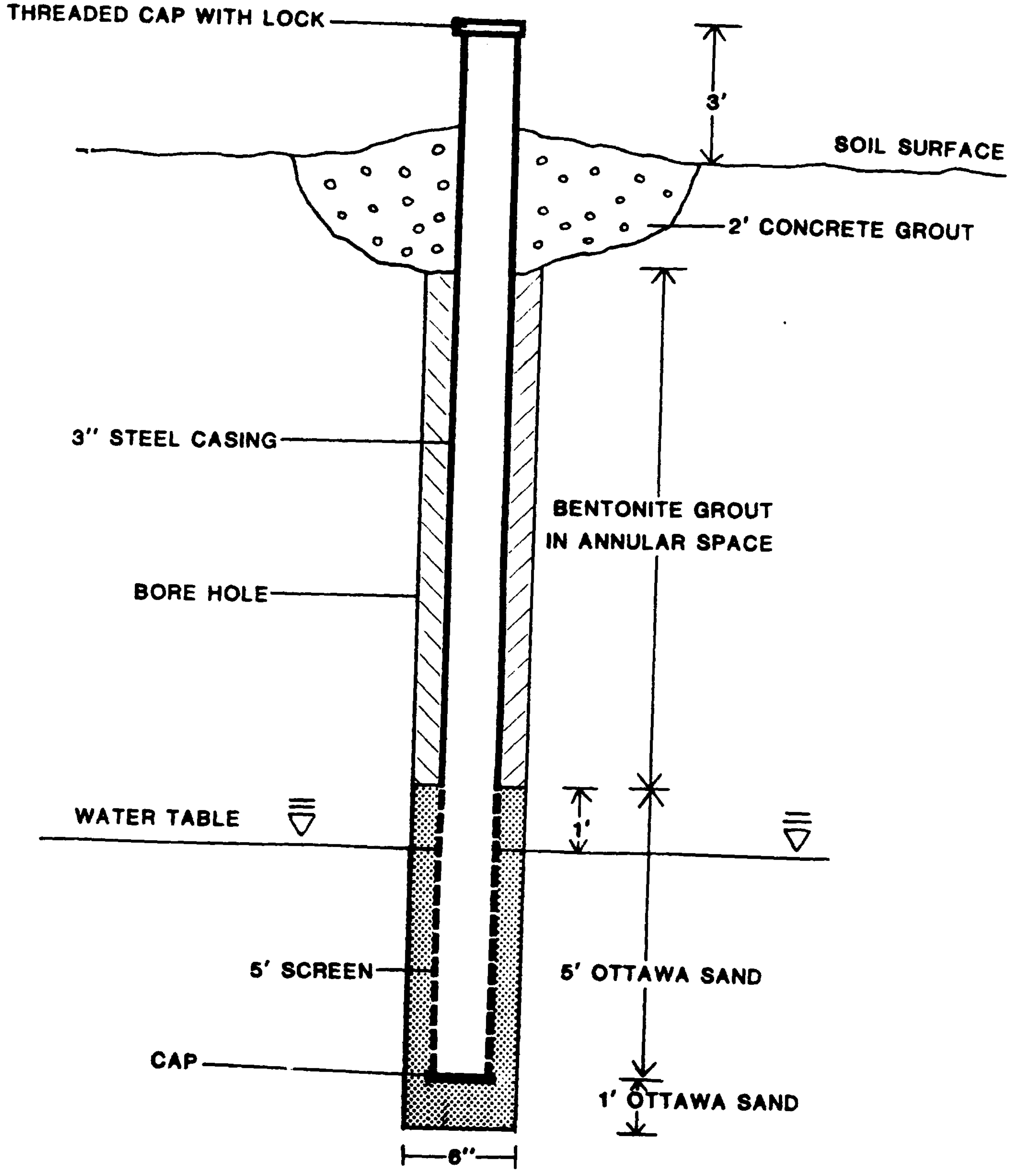
- High pressure hot water cleaning of the drilling equipment
- Rinsing of equipment with a methanol spray
- High pressure hot water final rinse

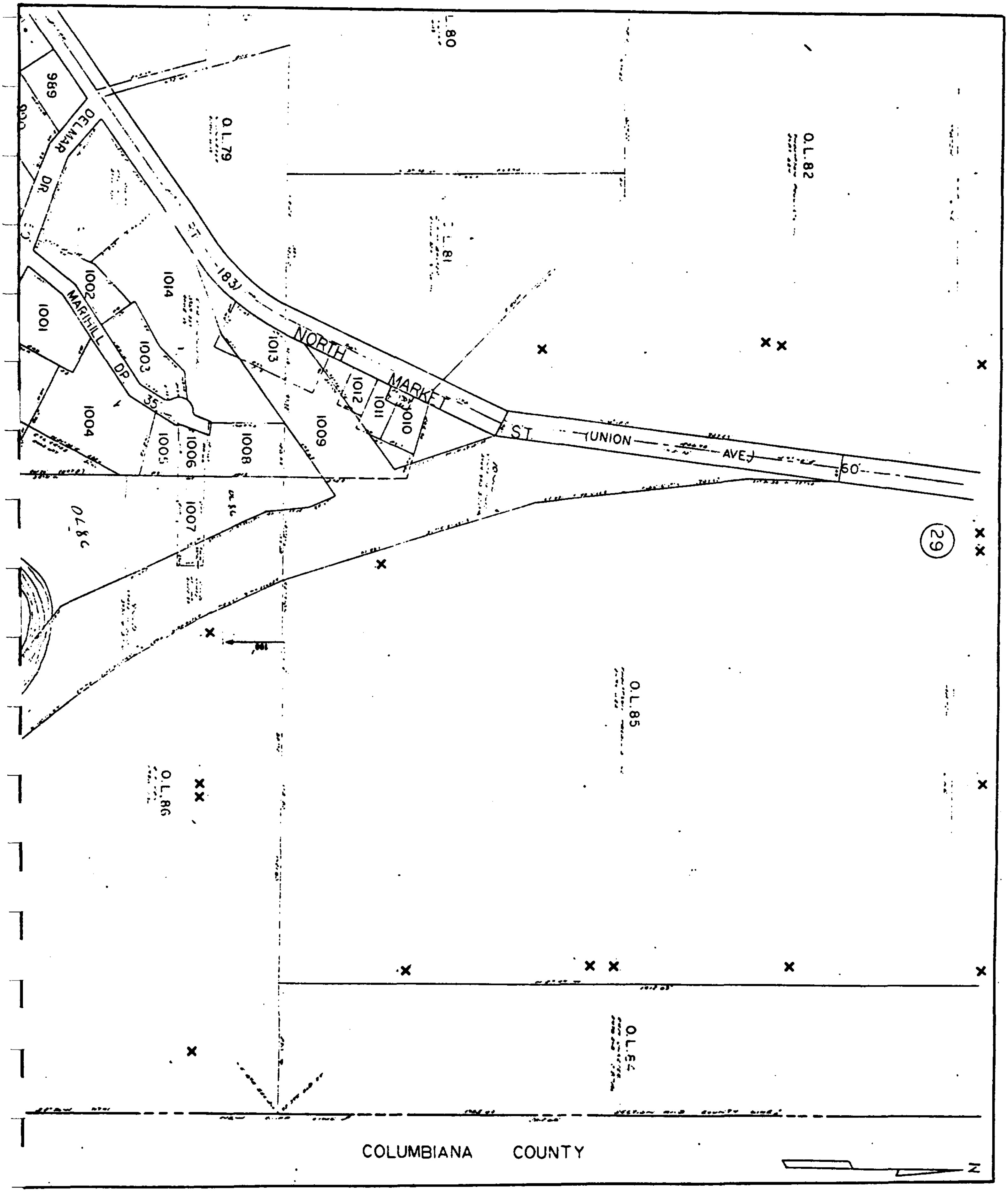
All waste water generated from this entire washing process shall be collected and disposed of in the pond

All soil material collected and not used for samples shall be disposed of in the pond.

No equipment shall be removed from a drilling site at any time without first being decontaminated in accordance with the above procedure.

TYPE A MONITORING WELL




O.L.79
O.L.80
O.L.81
O.L.82
989
DELMAR DR.
1001
1002
MARHILL DR.
1003
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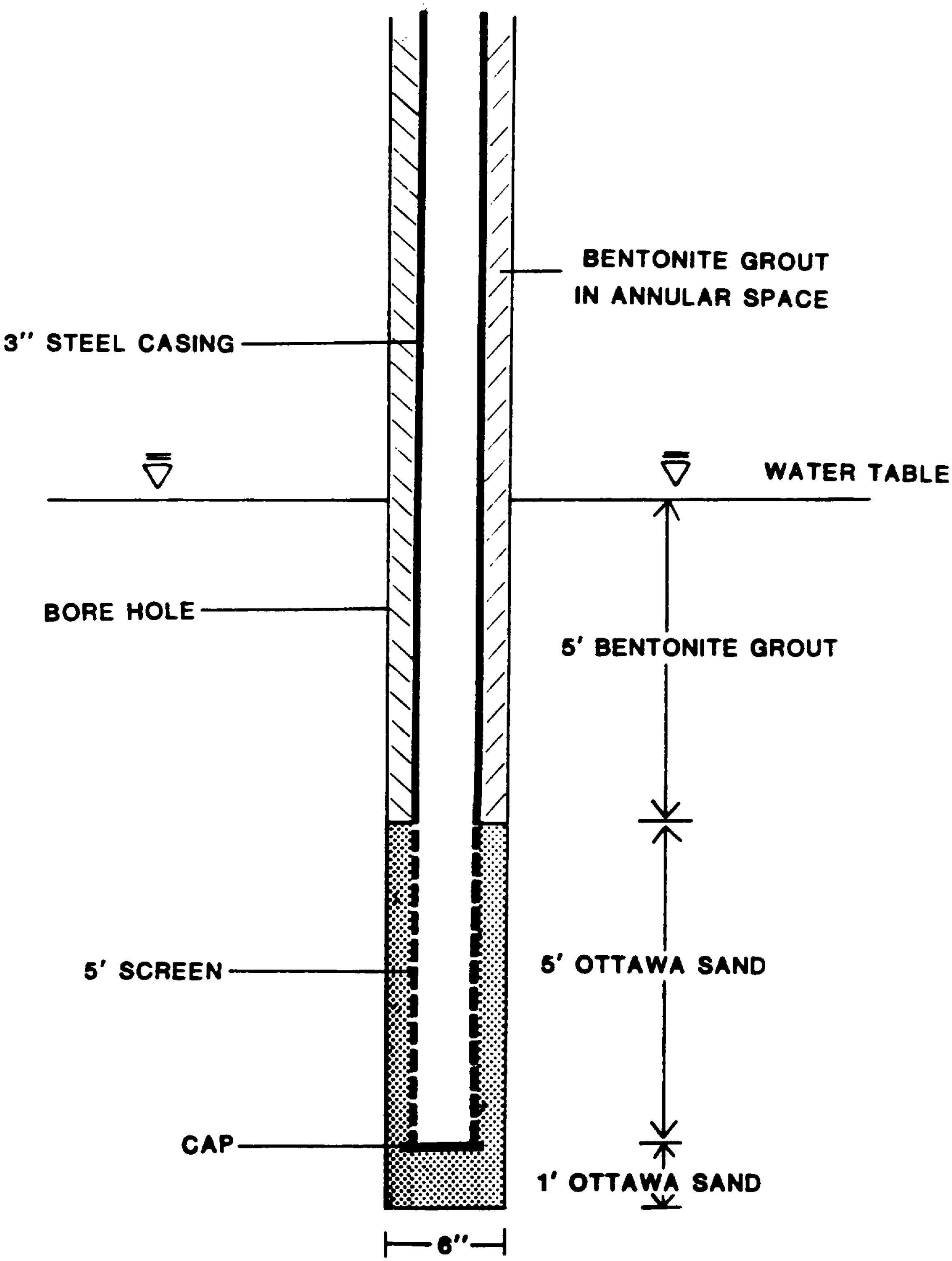
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
35
183
NORTH MARKET ST.
(UNION AVE.)
60'
29
O.L.85
O.L.86
O.L.84
COLUMBIANA COUNTY
N

TYPE B MONITORING WELL

(UPPER STRUCTURE THE SAME AS TYPE A)



ADDITIONAL DRILLING SPECIFICATIONS

Beyond measures delineated within the General Drilling Specifications, the following steps shall be taken to avoid contamination:

(1) Within the PCB contaminated area, surface cover shall be removed to a minimum depth of one (1) foot with a minimum radius of three (3) feet about the well point by use of a backhoe;

(2) The backhoe bucket, all drilling equipment, casing, weights, samplers, and augers shall be cleaned prior to drilling the first hole and when drilling equipment is moved to a new location.

The cleaning process shall consist of:

- High pressure hot water cleaning of the drilling equipment;
- Rinsing of equipment with a methanol spray; and
- High pressure hot water final rinse.

Both wastewaters generated by the above process, as well as soil materials collected but not used for samples, will be disposed of as follows:

- Within the uncontaminated area, wastewaters and soils are to be disposed of in the Wax Ditch (see Attachment A).
- Within the contaminated area, wastewaters and soils are to be disposed of at a designated decontamination area at the South Pond (see Attachment A).

The decontamination area should be constructed such that wash and rinse waters drain into the South Pond. To facilitate work within the contaminated area, you are authorized to build a bridge across the wax ditch at a cost not to exceed $500. Entry into and exit from the contaminated area will be at the extreme north end of the swale. Visclean plastic shall be laid over the swale to avoid excessive contamination when crossing the swale. Once brought into the contaminated area, drilling (and other equipment) should not be removed from the contaminated area until all wells are completed. Upon completion of the monitoring wells in the contaminated areas (or in the event that it is necessary to remove equipment prior to completion of the monitoring wells), all materials and equipment removed from this area must be decontaminated as outlined above. Plastic material at the entry point will be removed and disposed of upon completion of monitoring wells.

A final consideration of the well drilling program is that of worker safety. In the uncontaminated areas, good operating practice will provide sufficient worker protection. In the contaminated area, the following protective gear must be worn at all times when drilling is being conducted:

- Tyvek suits (disposal)
- Neoprene rubber gloves
- Rubber boots (disposal)

If during drilling soils, waters, or other materials are encountered which appear to be contaminated (for example, if oily water is encountered) you are to:

(1) Cease work immediately;

(2) Notify Clement Associates; and

(3) Notify Dr. Marvin Stevens of Alert Laboratories.

Upon completion of an analysis to determine the nature and extent of contamination, you will be directed by Clement Associates as to a proper course of action (for example, continue to drill, decontaminate and begin the next well, etc.).

To summarize, avoidance of inadvertent well contamination is of paramount importance. By adhering rigorously to the above procedures we will greately reduce the changes of monitoring well contamination.

Installation of 4 Additional Monitoring Wells in 1982

ATTACHMENT A: DRILLING SPECIFICATIONS

Drilling Method

Monitoring wells shall be drilled by the cable tool method. In unstable unconsolidated formations the hole shall be advanced by driving the casing and bailing, and no sample shall be taken except when the casing has been driven ahead of the bottom of the hole; in stable unconsolidated formations, samples shall be taken by drilling three (3) feet and bailing before or after driving the casing to the bottom of the drilled material. In consolidated formations, the hole is advanced by drilling and samples taken by bailing. Casing may be run later to insure that the hole does not cave. The CONTRACTOR shall be responsible for designing, controlling, and carrying out a drilling program that conforms to sampling method requirements given below.

Driller's Logs and Reports

During the drilling of monitoring wells the CONTRACTOR shall prepare and keep a complete log setting forth the following:

- The reference point for all depth measurements
- The depth at which each change of formation occurs
- The depth at which the first water was encountered
- The depth at which each stratum was encountered
- The thickness of each stratum
- The identification of the material of which each stratum is composed such as:
  - Clay

- Sand or silt
- Sand and gravel - Indicate whether gravel is loose, tight, angular or smooth; color
- Cemented formation - Indicate whether grains (if present) have natural cementing material between them; e.g. silica, calcite, etc.
- Hard rock - Indicate whether sedimentary bedrock, or igneous rock (granite-like, basalt-like, etc.)

- The depth interval from which the formation sample was taken
- The depth to static water level (SWL)[1] and changes in SWL with well depth
- Total depth of completed well
- The depth of the surface seal
- The nominal hole diameter of the well bore above and below the casing seal
- The amount of cement (number of sacks) installed for the seal
- The depth and description of the well casing
- The description (to include length, diameter, slot size, material and manufacturer) and location of well screen and screen envelope (filter)
- The depth and description of the bentonite seal

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[1]Water collecting in the bore hole must be allowed to equilibrate for 1.5 hours before the SWL is measured.

Formation Sampling Interval, Handling and Identification

Formation samples are to be taken at three (3) foot intervals, and at any pronounced change of the formation.

One (1) 100 in^3 representative sample shall be obtained from each sampling interval. Immediately after retrieval formation samples shall be placed in approved containers, securely closed to avoid spillage and contamination and clearly labeled with the following information:

- Location of the well
- Name and number of well
- Depth interval represented by the sample
- Date taken
- Time taken

Formation samples, immediately after being placed in container, shall be labeled clearly, either directly on the container or on a tag attached thereto, using ink, indelible pencil or other medium that is resistant to moisture and sunlight. The label shall not be readily removable from the container. The CONTRACTOR shall be responsible for the safe storage of formation samples until such time as they are accepted by CLEMENT ASSOCIATES, INC.

Method of Construction

The CONTRACTOR shall use the cable tool (percussion) method for drilling the monitoring wells.

Case Selection

All well casing shall be new. They shall be made of steel which conforms to ASTM specifications. The casing shall be of three (3) inch diameter. Length of casing will vary and will depend on where SWL is encountered. (The top of the screen will be placed three (3) feet above the observed SWL after the water has been allowed to equilibrate for 1.5 hours. See the enclosed drawing.)

Casing lengths shall be joined watertightly by a method appropriate to the material used so that the resulting joint shall have the same structural integrity of the casing itself. A threaded joint is the preferred method.

Well Grouting

Where specified a concrete grout shall be used. The grout shall consist of a mixture of Portland cement (ASTM C150), sand, coarse aggregate and water in the proportion of at least five (5) bags of cement per cubic yard of concrete to not more than six (6) gallons of clean water per bag of cement. The use of special cements, bentonite to reduce shrinkage or other admixtures to reduce permeability, increase fluidity and/or control time of set and the composition of the resultant slurry must be approved by CLEMENT ASSOCIATES, INC.

Bentonite grout shall be placed in accordance with the enclosed drawing. The composition of the bentonite grout is also specified in the enclosed drawing.

Methods of installation of bentonite grout and concrete grout shall be approved by CLEMENT ASSOCIATES, INC.

Screen and Filter Material

A continuous three (3) inch diameter slot wire wound stainless steel screen (20 slot), five (5) foot length shall be used and installed according to the method deemed appropriate by the CONTRACTOR. The screen shall be placed in accordance with the enclosed drawing.

The bottom of the screen shall be capped with appropriate cap or plug. The screen shall be joined to the casing by a method deemed appropriate by the CONTRACTOR.

Filter materal shall consist of Ottawa sand or similar material and be placed according to the method deemed appropriate by the CONTRACTOR and approved by CLEMENT ASSOCIATES, INC. Location depth and width of filter shall be in accordance with the enclosed drawings.

Well Development

Each monitoring well shall be developed according to the method deemed appropriate by the CONTRACTOR and approved by CLEMENT ASSOCIATES, INC.

Special Consideration

Only clean, noncirculating water shall be used as wash water for drilling. All drilling equipment, casing, weights, samplers, augers, shall be cleaned prior to drilling the first hole and when drilling equipment is moved to a new well location. The cleaning process shall consist of:

- High pressure hot water cleaning of the drilling equipment
- Rinsing of equipment with a methanol spray
- High pressure hot water final rinse

All waste water generated from this entire washing process shall be collected and disposed of in the pond.

All soil material collected and not used for samples shall be disposed of in the pond.

No equipment shall be removed from a drilling site at any time without first being decontaminated in accordance with the above procedure.

To minimize suface contamination reaching groundwater, surface cover shall be removed to a minimum depth of one (1) foot with a minimum radius of three (3) feet about the well point by use of a backhoe.

To summarize, avoidance of inadvertent well contamination is of paramount importance. By adhering rigorously to the above procedures we will greatly reduce the chance of monitoring well contamination.

A final consideration of the well drilling program is that of worker safety. In the uncontaminated areas, good operating practices will provide sufficient worker protection. In the contaminated area the following protective gear must be worn at all times when drilling is being conducted:

- Tyvek suits (disposable)
- Neoprene rubber gloves
- Rubber boots (disposable)

If potentially contaminated soils, waters, or other materials are encountered during drilling (for example, if oily water is found), the CONTRACTOR is to

(1) Cease work immediately;

(2) Notify Clement Associates; and

(3) Notify Dr. Marvin Stevens of Alert Laboratories.

Upon completion of an analysis to determine the nature and extent of contamination, CONTRACTOR shall be directed by CLEMENT ASSOCIATES, INC., as to the proper course of action.

ATTACHMENT B

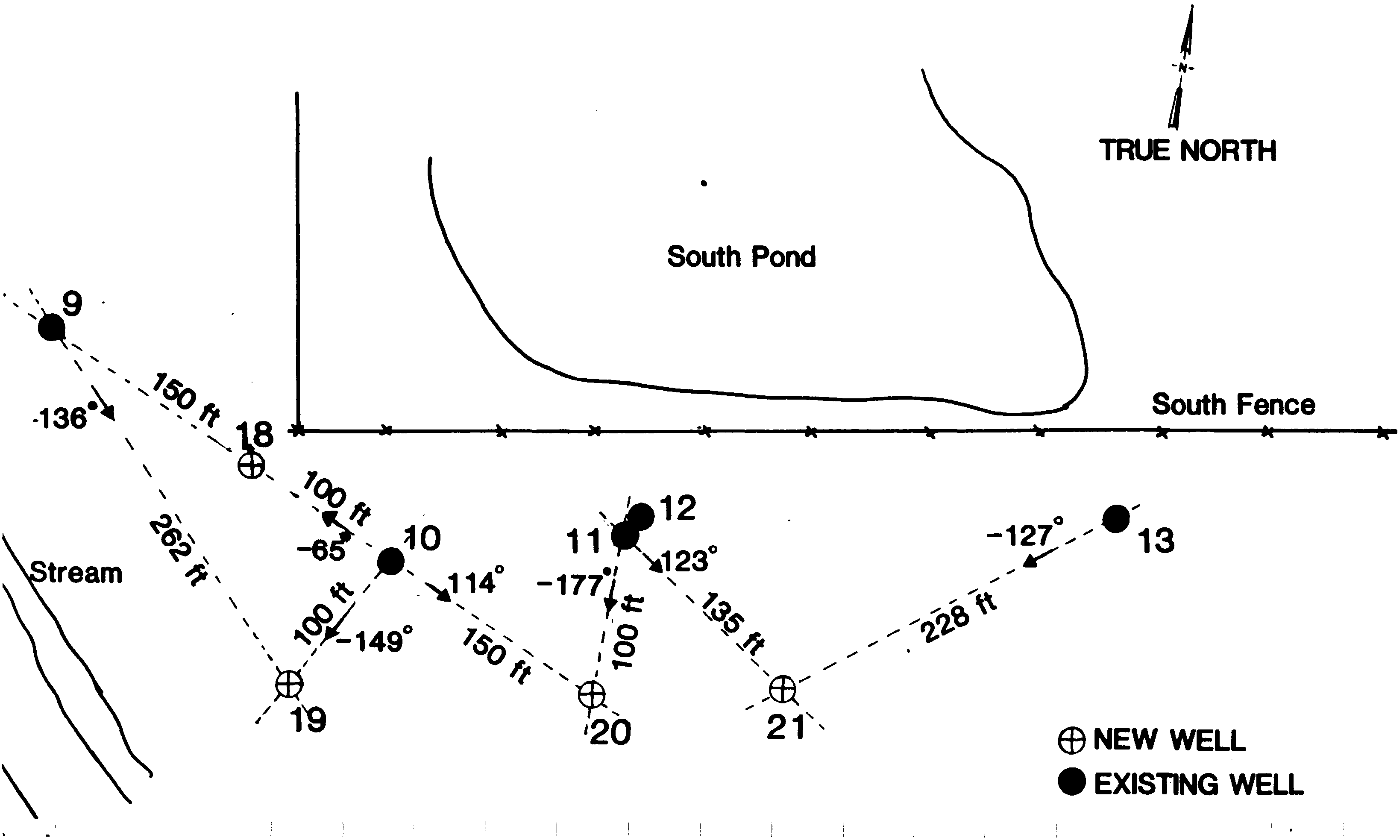
MONITORING WELL LOCATIONS FOR WELLS 18, 19, 20, and 21

The locations for the new wells, Nos. 18, 19, 20, and 21, are depicted in the enclosed figure. Distances and directions from various landmarks are presented below:

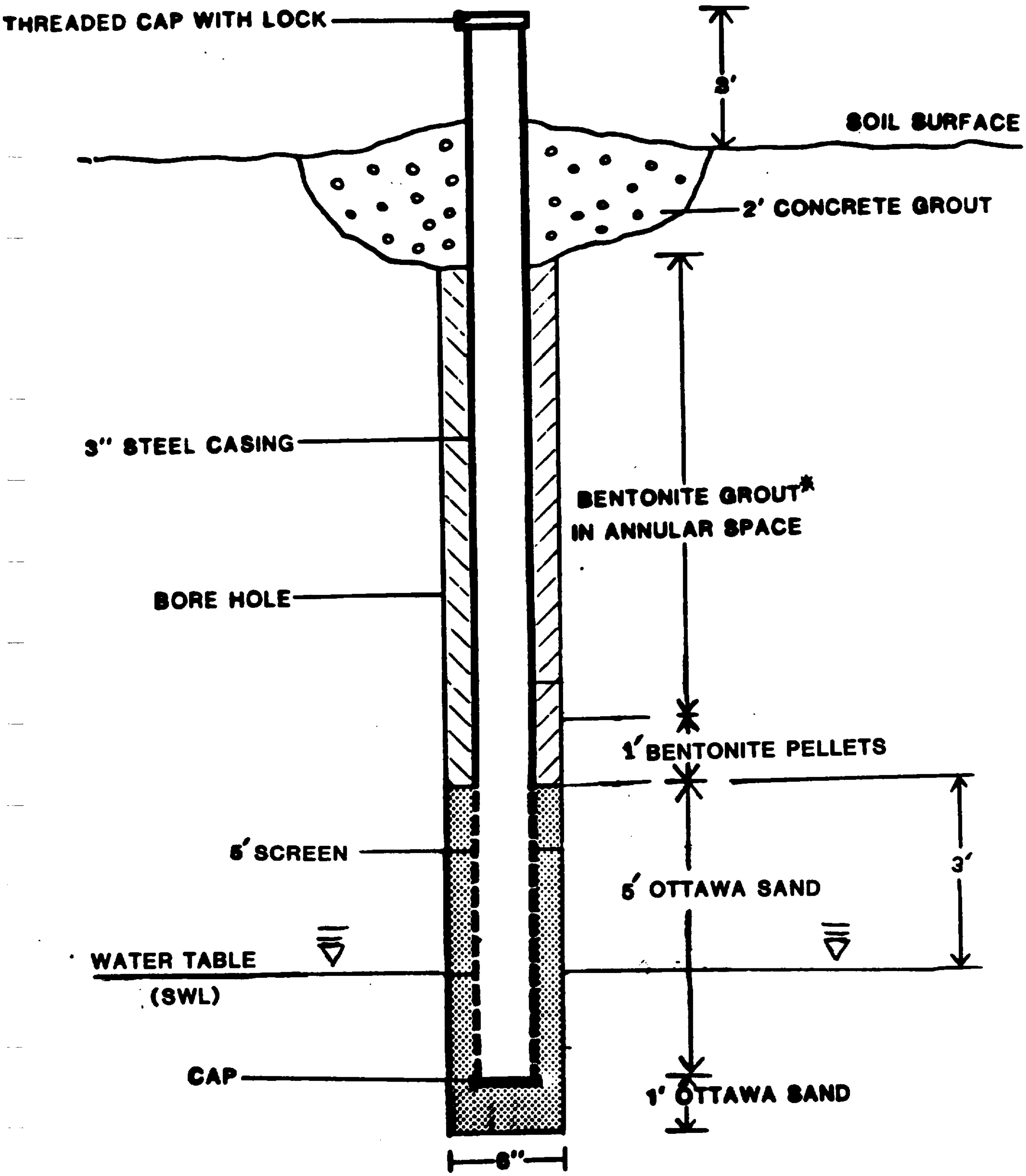
- Well 18 is located on a line connecting wells 9 and 10. It is 100 feet northwest of well 10 along this line, which is -65° from true north. (Alternately, well 18 is 150 feet from well 9 along the same line.)
- Well 19 is 100 feet southwest of well 10 on a line that is -149° from true north. (Alternately, well 19 is 262 feet southeast of well 9 on a line that is +136° from true north.)
- Well 20 is 150 feet southeast of well 10 on a line that is +114°. (Alternately, well 20 is 100 feet southwest of well 11 on a line that is -177°.)
- Well 21 is 135 feet southeast of well 11 on a line that is +123°. (Alternately, well 11 is 228 feet southwest of well 13 on a line that is -127° from true north.)

A figure will be sent under separate cover.

LOCATIONS FOR WELLS #18, 19, 20, AND 21



FRY PROPERTY MONITORING WELLS



*(4:4:1–CEMENT:WATER:BENTONITE)

Procedure for Establishing PCB Sampling Protocols

GROUNDWATER MONITORING PROGRAM
FOR THE TRW SITE IN MINERVA, OHIO

Introduction

This work plan outlines procedures for monitoring groundwater at the TRW Minerva site. Several phases of work are addressed in this plan. Accordingly, it is divided into three sections:

I. Preparatory study

II. Initial sampling procedure

III. Periodic monitoring procedure.

The first section outlines studies to determine that the sampling techniques to be employed in the remainder of this program are adequate for obtaining the desired information. Consequently, the latter sections are subject to amendments based on the results of Section I. Section II contains instructions for sampling the wells to be used the first time each well is sampled. The final section outlines procedures for sampling the wells on all subsequent visits.

I. Preparatory Studies

Plans for constructing and procedures for testing the oil sampler are presented in the first part of this section. The second part outlines a method for testing the tubing to be used in sampling groundwater.

A. Construction and testing of the oil sampling

The oil samplers are designed to require minimal time and expense to assemble. A diagram is presented in Figure 1.

Except for the specifications outlined in the figure, excessive precision is not required in the construction of each oil sampler. Slit lengths, for example, may be estimated visually. (Fractions in the diagram have been represented as decimal equivalents in the text solely to facilitate typing.)

Briefly, a thin-walled metal pipe with a 2.75-inch O.D. is cut into 1.5-inch lengths. Each resulting metal ring is used to construct a sampler in the following manner. Eight 0.125-inch long slits are cut at equal intervals around the bottom of the metal ring. (The "bottom" is later referred to as the "gauze side".) Eight 0.875-inch slits are cut in corresponding positions in the top of the ring. (The upper slits may have to be extended, see the notes in Figure 1.) A groove made by a single hacksaw blade is sufficient for the slit width. The sampler is completed by sandwiching and immobilizing an oil-absorbent gauze pad in the metal ring between the slits using small-gauge uninsulated wire that is wound as indicated in the figure.

The oil sampler is tested using a 3-inch I.D. glass or metal container. (Larger containers may be used if a 3-inch container is unavailable.) The sampler must be tested to distinguish between three situations: contaminated water, water with a concentrated oil film, and water with a dilute contaminated oil film. In the first case, a container is filled to a 4-inch depth with water saturated to 50 ppb with PCB. (The water must be free of oil or grease). The second and third containers are filled with clean water to a depth of 4 inches. In the second container, oil contaminated with 500 ppm PCB is added by syringe in a quantity sufficient to generate a 1 μ film on the water. (This is equivalent to 4.6 μl for a 3-inch I.D. container.) A 1-μ thick film of oil contaminated with 100 ppm PCB is introduced into the third container by syringe also.

The following sampling procedure is repeated for each of the three containers prepared above. A clean oil sampler is lowered (gauze side down) into the container until the sampler just contacts the liquid surface. The sampler is then allowed to "free fall" until it has completely submerged, but before it touches the bottom of the container. (The time required for each sampler to submerge is recorded.) The sampler is then withdrawn but it is held over the container and allowed to drip for approximately 10 seconds, which is long enough to simulate removal of a sampler from an actual well. Upon completion of this operation, the sampler is placed in a sealed container and stored for extraction and analysis. (The restraining wire may be cut if the gauze pad must be freed before extraction.) Analysis must be sufficient to detect a total of 1×10^{-7} g of PCB in the wet gauze. In addition, the oil sampler (weighed with or without the sealed container for the sampler) must be weighed before and after the sampler is dunked in a manner facilitating determination of the quantity of bulk liquid absorbed by the sampler. Finally, analysis of the sampler used in the dilute (100 ppm) film container should be performed in duplicate.

B. <u>Determination of the extent that tubing affects sampling results</u>

Tubing that is sufficiently flexible to be used with a peristaltic pump may affect PCB water samples in two ways. First, plasticizers may leach from the tubing, contaminate the water, and interfere with the analysis of PCB. Second, tubing material may adsorb PCB and distort subsequent analyses by lowering the concentration of PCB in the sampled water. The following test procedure will be used to identify such problems.

Twenty gallons of water contaminated with 1 ppb PCB are prepared and stored in a clean graduated reservoir. Following equilibration, a 1-gallon sample of this mixture is withdrawn and analyzed in duplicate to determine the level of contamination. To test the tubing, a clean 20-feet section of tygon tubing (either the type approved for food or for hospital use) is used to siphon the contaminated water from the reservoir to another container. During siphoning, half-gallon aliquots of water are withdrawn for analysis at the tubing discharge end. The following intervals are to be sampled:

(1) the 1st half-gallon

(2) the 3rd half-gallon

(3) the 11th half-gallon

(4) the 21st half-gallon

(5) the 38th half-gallon

Analysis shall be sufficient to detect 20 ppt of PCB.

II. Initial Sampling Procedure

Subject to the results obtained in Section I, the procedures outlined in this section should be followed invariably for each of the 18 test wells at the TRW site. These procedures apply to the first time the wells are to be sampled.

A. Equipment

The following equipment is necessary to execute the initial sampling plan. (The exact nature of this equipment and its source is left to the discretion of the contractor subject to approval by Clement Associates.)

- Nineteen oil samplers and containers described in Section I
- A variable speed peristaltic pump with a maximum pumping rate of at least 5 gallons/minute
- Sufficient tubing to allow two sets of clean tubing to be apportioned to each well
- A surveyor's chalk, "water-finder" paste, and a ruled steel tape with a modified surface to which chalk will adhere
- A vehicle for transporting up to 50 gallons of evacuated water from each well in the contaminated areas to the south pond
- A container for facilitating transport and transferral of evacuated water from each well to the pond (a 55 gallon drum with a bottom tap is suggested)
- Appropriate equipment for storing and transporting water samples for analysis
- A portable meter or other apparatus used to determine the pH of well water on site
- A hand held site, a float and two ruled sticks for measuring the water level in south pond
- Appropriate protective clothing

B. Procedures for sampling each well

The following sequence for executing each of the operations listed has been developed to minimize interference and should be adhered to rigorously.

The first two operations: "testing for the presence of an oil film" and "water level determination" should be performed sequentially on each of the 18 wells before proceeding with the remaining sampling. (This is because the water level should be determined in all wells within a short period of time to facilitate comparison.)

The 18 test wells should be divided into two sets: those in the contaminated area and those in uncontaminated areas. Except for the operations discussed in the previous paragraph, subsequent procedures will be simplified if wells in each set are sampled as a group. In addition, a gate should be installed in the south fence allowing access to all wells in contaminated areas via contaminated ground. This will minimize the possibility of spreading contamination to new areas due to vehicular and pedestrian traffic. Further, dedicating a vehicle for water transport to the contaminated area will reduce the number of times that decontamination operations are required. Evacuated well water from wells in noncontaminated areas may be transported to the edge of the wax ditch for disposal using any available vehicle. A dedicated vehicle is not required, because the waxt ditch can be reached without crossing contaminated ground.

1. Testing for the presence of an oil film

When the well is first opened, a preweighed oil sampler is lowered into the well until contact with the water surface is perceived. Tension is then reduced on the sampler guide string for sufficient time to allow the sampler to submerge. (This interval was determined in Section I.) However, under no circumstances should the sampler be allowed to submerge to a depth greater than 2 inches. The sampler is then withdrawn and placed in a sealed container in preparation for transport and analysis. Prior to analysis, the sampler is weighed to determine the quantity of water absorbed. A nineteenth oil sampler should be included for analysis as a field blank. It should be treated as all the other samplers except that it is not lowered into a well.

2. Water level determination

The water level in each well should be measured following use of the oil sampler. To measure the water level, a ruled metal tape is coated on the blank side with chalk and the ruled side with "water-finder" paste. (The paste changes color upon contact with water.) Both sides should be coated a distance of at least 10 inches from the end of the tape. The tape is then lowered into the well until the coated portion has partially, but not completely, submerged. (A lead weight may be affixed, if necessary, to the bottom of the tape to facilitate this procedure.) The tape reading at the top of the well riser is noted and recorded to the nearest 0.125-inch. The tape is then removed from the well and the level of the water line on the "waterfinder" is recorded as well as the level of the wet mark on the chalk. These should also be recorded to the nearest 0.125-inch. (It may be necessary when reporting this distance to adjust for the quantity of water removed by the oil sampler.) The level of the water in the well is related to the distance between the top of the riser and the water mark on the tape. (If the wet mark on the chalk and the water mark on the "water-finder" do not correspond, this indicates the presence of an oil layer on the water. The thickness of this film is the distance between the two marks, and is recorded to the nearest half-inch in the logbook on the same page as the other tape readings. If a difference does exist, it is also important to note whether the reading on the chalk or the "water-finder" is higher.

To decontaminate the metal tape for use in the next well, it is first wiped clean to remove all materials that may absorb PCB. Following a thorough physical wiping, the tape is rinsed liberally with distilled water. Excess water is shaken off and the tape is swirled in an hexane/acetone bath. It is then rinsed with additional acetone. Finally, the tape is rinsed again with liberal quantities of distilled water. (Waste rinses that have been in contact with the tape will be collected and dumped in south pond.) Cloth used for wiping the tape will be placed in an appropriately labeled 55-gallon drum for storage and eventual disposal.) The clean tape must then be coated with new chalk and "water-finder."

The water level in south pond is also to be measured using a hand held level site. A float supporting a vertical stick ruled to 1 inch is placed in south pond, see Figure 2 (the "zero" on the stick should be set at the level of the water surface.) A similar stick is secured to a neighboring monitoring well riser with zero corresponding to the top of the riser. The water level in south pond is then determined by siting both sticks with the hand held site and recording the respective vertical distances from the horizontal defined by the optical piece to the surface of the pond and to the top of the well riser. This level is recorded to within 1 inch.

3. Water sampling and analysis

Subject to modifications derived from Section I, sampling of the groundwater in each of the 18 wells is performed in the following manner. Assuming a significant oil layer does not exist, this procedure is to be repeated for each of the 18 wells at the TRW site. If a significant oil layer is detected with the metal tape in any well, the procedure to be used for sampling that well appears in Section II-B-4 below.

First, the distance from the top of the riser to the middle of the screen in the well being sampled is obtained from Appendix A of this document. This distance is marked on a clean piece of tubing which has sufficient additional length to pass through the peristaltic pump and into a wastewater storage drum. The tube is lowered slowly into the well until the mark reaches the top of the riser. At this point, the end of the tubing should rest at a depth corresponding to the middle of the well screen. Precautions must be taken to prevent oil that may be present from entering the tubing as it is lowered into the well. This can be accomplished by using the flow of the pump to force air through the tubing as it is lowered. Once the tubing has reached the proper depth, the pump flow is reversed and water is withdrawn from the well. The first gallon withdrawn should be collected and stored for analysis. A one gallon sample should provide sufficient water to allow for the possibility that a standard oil and grease analysis may need to be performed on the sample in addition to the analysis for PCB. (All sample containers should be appropriately labeled, see Section II-C below.) The pH of the well water is determined at this point. The method used for determining the pH will be developed through discussions between the contractor and Clement Associates.

The well is now evacuated. Unless the well is pumped dry to the level of the tubing, three well volumes of water are evacuated from the well using the maximum available pumping speed. The <u>total</u> quantity of water to be removed from each well is determined from the appropriate chart for the well labeled "Well Water Removal Charts." The charts are found in Appendix A. (If the well is actually pumped dry, additional evacuation is not required.) Evacuated water is added to the wastewater container for transport and is dumped in south pond (or the wax ditch). The tubing is withdrawn from the well while the pump is running so that any film remaining on the water surface is removed. Used tubing is deposited in an appropriately labeled waste drum and stored for disposal.

Sufficient time must now elapse before additional sampling is performed so that the well has time to recharge naturally. (This means that the water level must return to within 6 inches of the level originally determined.) The well should be capped while it is recharging to minimize the possibility of introducing external contaminants.

After the well has recharged, a second piece of clean tubing is marked as before and inserted into the well in the same manner (with the pump blowing air). Once again, when the tubing has reached the proper depth, a gallon sample is withdrawn and stored for analysis. This piece of tubing is discarded in the same manner as the first piece. The well must then be capped and relocked. (Note: wells should be sampled in the same sequence that they are evacuated so that each well recharges for the same period of time.)

4. <u>Sampling Wells Containing a Significant Oil Layer</u>

Once a significant oil layer has been detected in a particular monitoring well the following modifications should be incorporated into the sampling procedure. (Any oil layer detected by the metal tape during determination of the water level should be considered significant. The minimum oil layer thickness that can be detected by this method is a half-inch.)

Prior to water sampling, a modified bailer with valve open is lowered until the bottom of the bailer is 6-inches below the oil layer. (This depth is determined by marking the distance obtained from the metal tape on the bailer or guide.) The valve is then closed and the bailer is withdrawn. When the bailer is removed from the well, a sample of the oil layer is drawn by syringe from the bailer and placed in a sealed container for storage and analysis. The bailer is cleaned using the same procedure outlined in Section II-B-2 for cleaning the metal tape.

After the oil layer is sampled, a clean section of tubing is attached to the pump and, with the pump running, lowered slowly into the well. As the tubing is lowered the oil layer will be drawn up and removed from the well. Water equivalent to three well volumes, as determined from the tables in Appendix A, are then evacuated from the well. After the well has recharged, a water sample is obtained from the well in the same manner outlined in the last paragraph of Section II-B-3 for the second water sample. However, if a signficant oil layer has reformed and is detected when the well depth is measured following recharge, the above procedure is not applicable, and a new procedure will have to be devised.

C. Sampling handling and analysis

Samples will be collected, stored, and transported in a manner assuring the chemical integrity of the sample until analysis can be performed. In addition, samples will be appropriately labeled to provide ready identification (including proper chain-of-custody protocols). A bound log book will be maintained with complete information on the conditions associated with the taking of each sample including:

- the time and date each sample was collected
- the nature of the sample (e.g., water sample before or after evacuation)
- the location from which the sample was obtained
- relevant observations (odors, colors, etc.)
- the pH of the well water
- other pertinent information

Information on the water level should also be recorded in this notebook including:

- the water level in each well and the date and time the level was measured
- the presence of oil and the depth of such a layer
- the water level in south pond

Water samples will be analyzed in a manner sufficient to detect PCBs to a level of 20 ppt. Samples will be of sufficient quantity to allow for the possibility that a standard oil and grease analysis may have to be performed in addition to the PCB analysis. (A sample size of one gallon is expected to be sufficient for both purposes.) Oil or grease should be analyzed in a manner sufficient to detect a level of 1 ppm. Oil and grease analyses of well water will be required if any of the following three conditions are met:

(1) The oil sampler test is positive

(2) A significant oil layer is detected in any well

(3) The PCB concentration in a water sample is above 50 ppb

Finally, when water samples are drawn, a sufficient volume should be taken from one upgradient shallow well and one down-gradient shallow well to allow duplicate analysis of each sample.

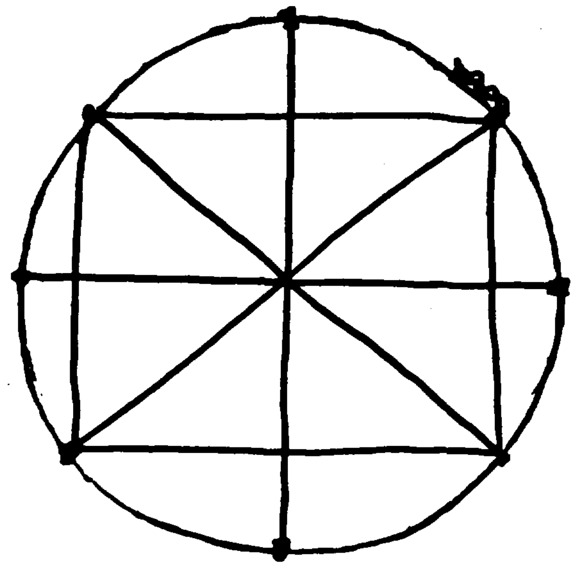
III. Periodic Monitoring Procedure

Subject to the results obtained in Section I, the procedures outlined in this section should be followed invariably for each of the 18 test wells at the TRW site. This procedure applies to sampling on all visits subsequent to the initial sampling program:

(1) Well water levels should be recorded bimonthly in the manner outlined in Section II-B-2. The pond level should also be recorded at the same time.

(2) Water samples should also be obtained bimonthly (subject to approval by Clement Associates) in the manner outlined in the last paragraph of Section II-B-3.

Figure 1: Suggested Oil Sampler Design



Suggested wire array across top and bottom

Notes through the diagram shows a symmetric design, it is advantageous to modify the design in the following manner: The bottom slits should be short (on the order of 1/8"). This will effectively minimize the disturbance due to the metal ring impacting the water prior to contact with the gauze pad. The upper slits can be legthened accordingly. (See #1: slitdepth)

The slit separation (#2 in diagram) is a function of the gauze pad bulk. The distance between the top and bottom slit must be sufficiently small to allow the wound wire to apply pressure and hold the pad firmly.

The height of the cylinder metal ring (#3) must be sufficient to prevent the sampler from tipping as it is lowered into the well.

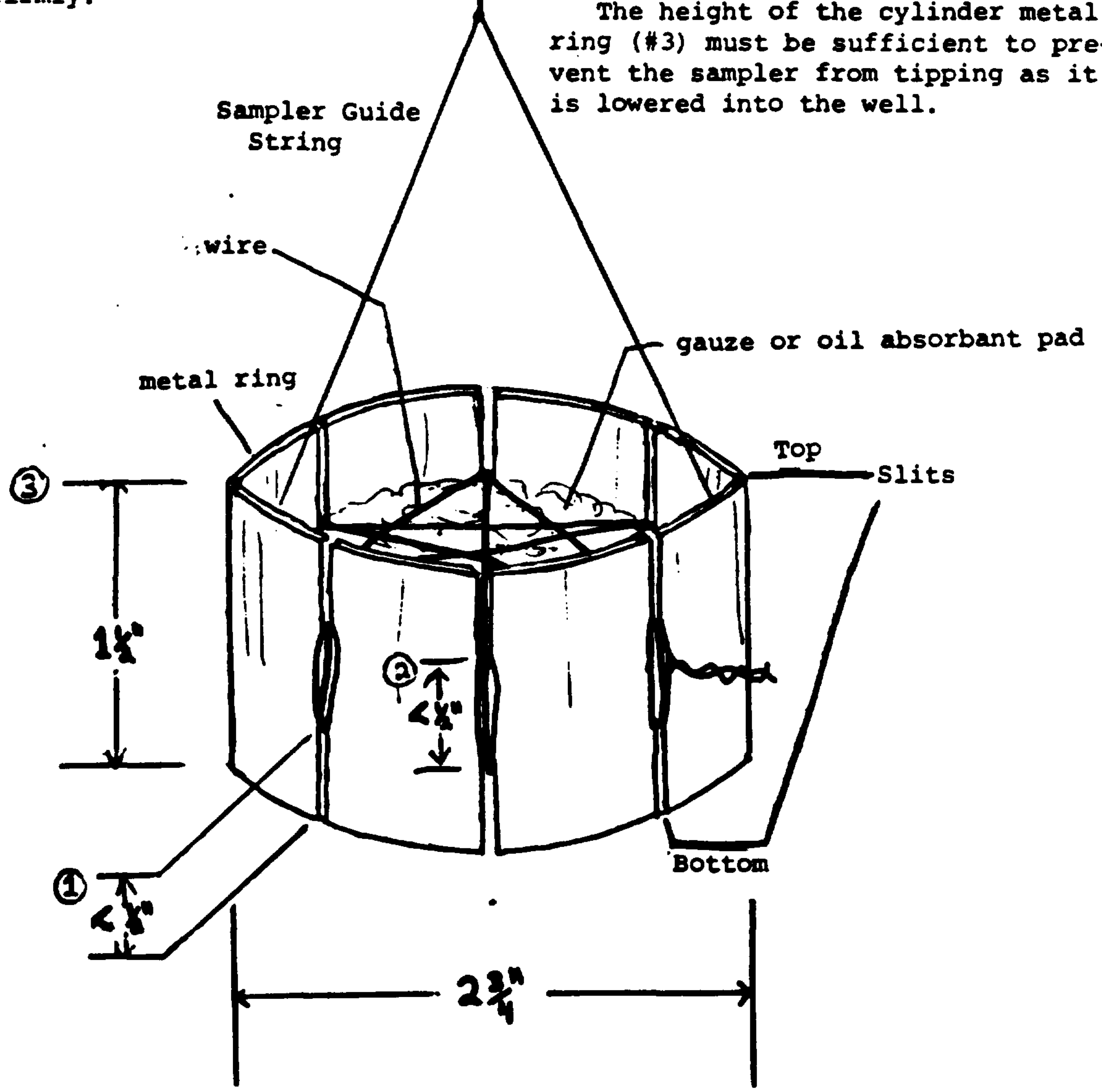
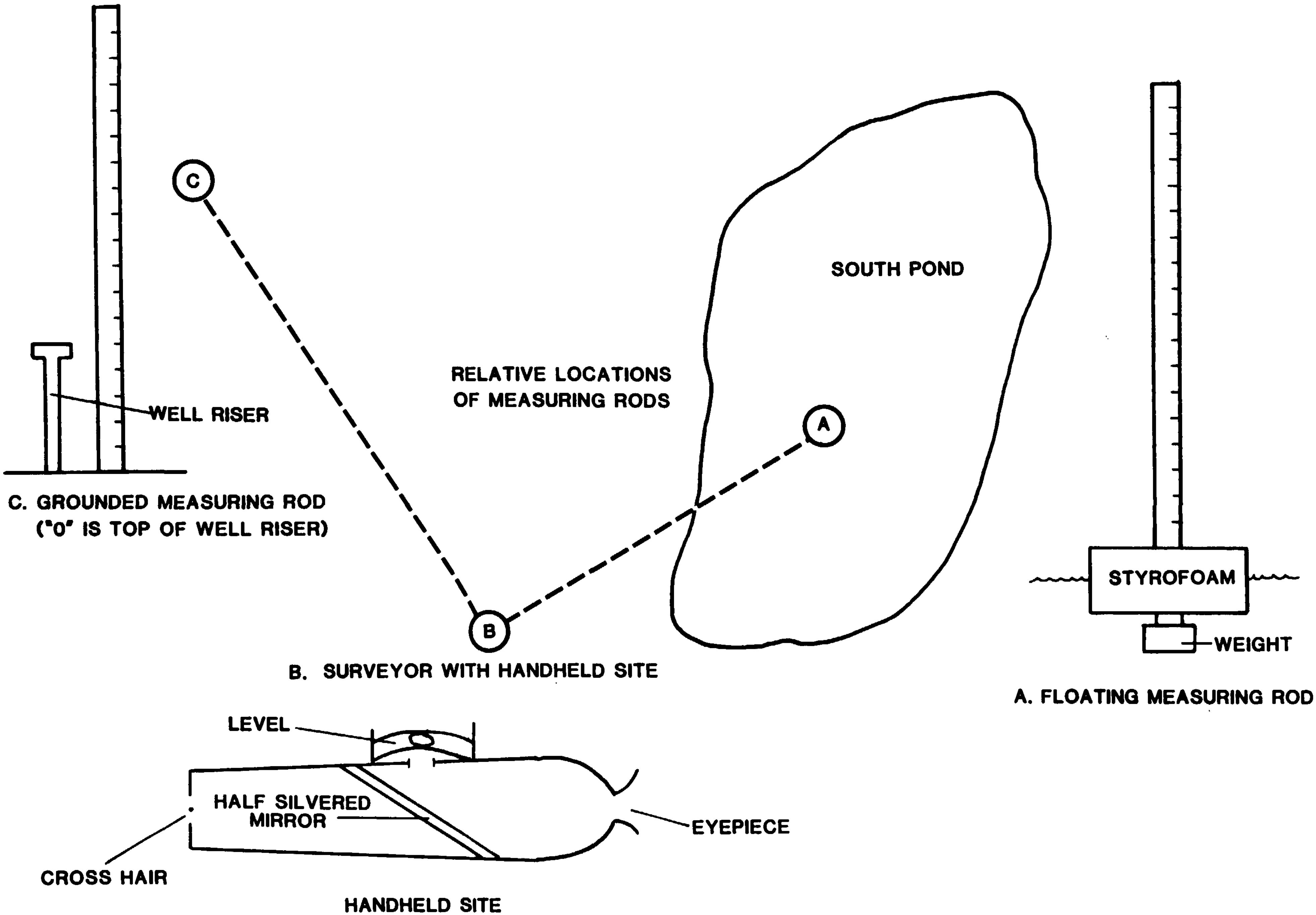


FIGURE 2

STRATEGY AND EQUIPMENT FOR MEASURING THE WATER LEVEL IN SOUTH POND



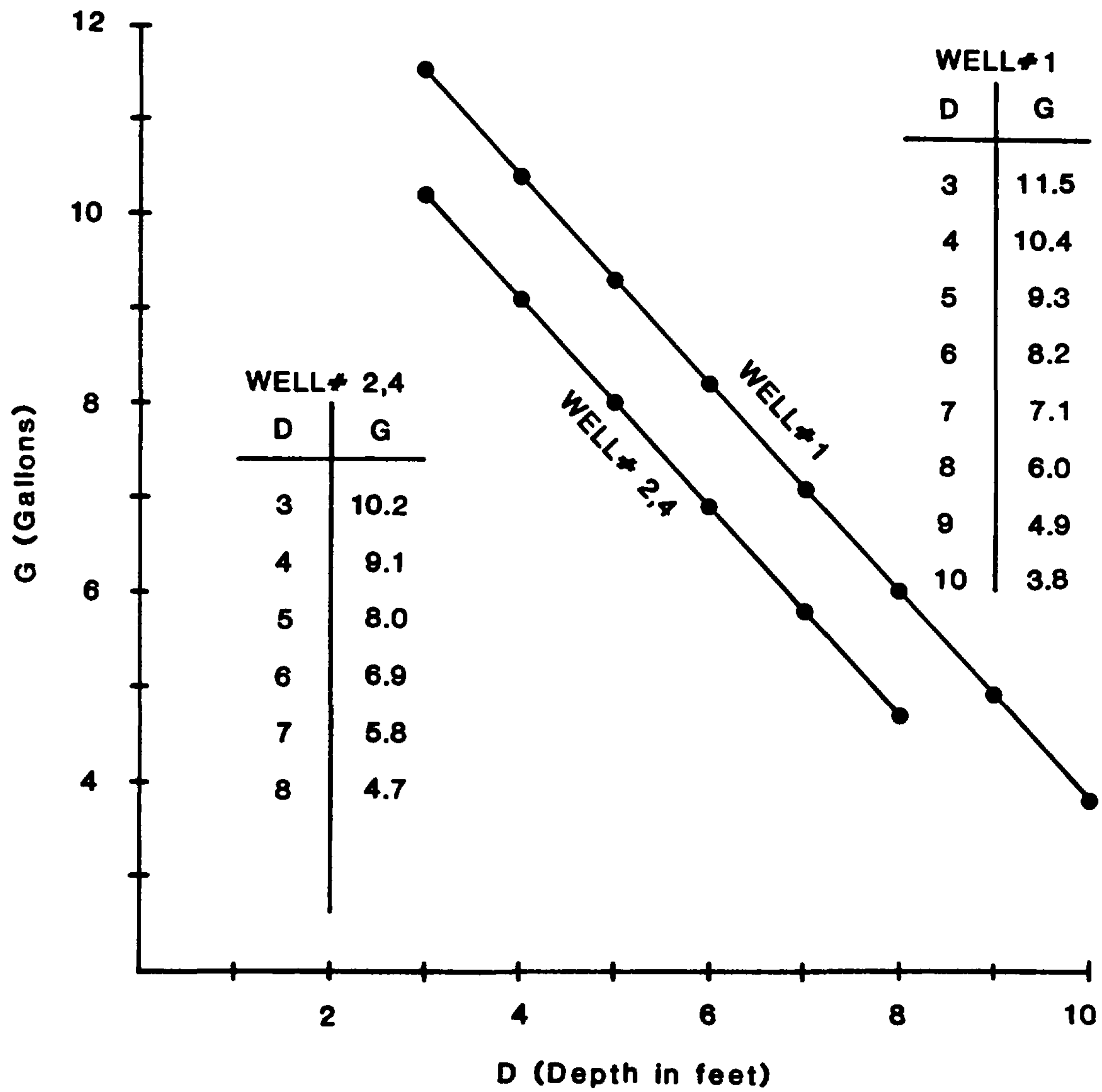
APPENDIX A

Appendix A contains the reference information necessary for sampling water from monitoring wells at the TRW site. Each page has information on two to five wells. The wells are not placed in numerical order, but Table A-1 is presented to locate information for specific wells. Two pieces of information are supplied for each well. The first, located at the bottom of each page, is the midpoint screen depth as measured from the top of the well riser. Graphs showing the relationship between the depth of the water level in each well and the volume to be evacuated from each well are also presented. This relationship is tabulated for specific depths. The depths of the water level, D, is measured from the top of the well riser. The volume to be evacuated from each well, G, is actually three times the volume of the well at the particular water level. This volume is removed after initial sampling of the well, but before all subsequent water sampling.

TABLE A-1

Well Number	Page Number	Well Number	Page Number
1	A-2	10	A-6
2	A-2	11	A-3
3	A-3	12	A-6
4	A-2	13	A-6
5	A-4	13a	A-6
6	A-4	14	A-5
7	A-4	15	A-7
8	A-5	16	A-7
9	A-6	17	A-3

INFORMATION FOR WELLS NUMBER 1, 2 AND 4



WELL# 2,4

D	G
3	10.2
4	9.1
5	8.0
6	6.9
7	5.8
8	4.7

WELL# 1

D	G
3	11.5
4	10.4
5	9.3
6	8.2
7	7.1
8	6.0
9	4.9
10	3.8

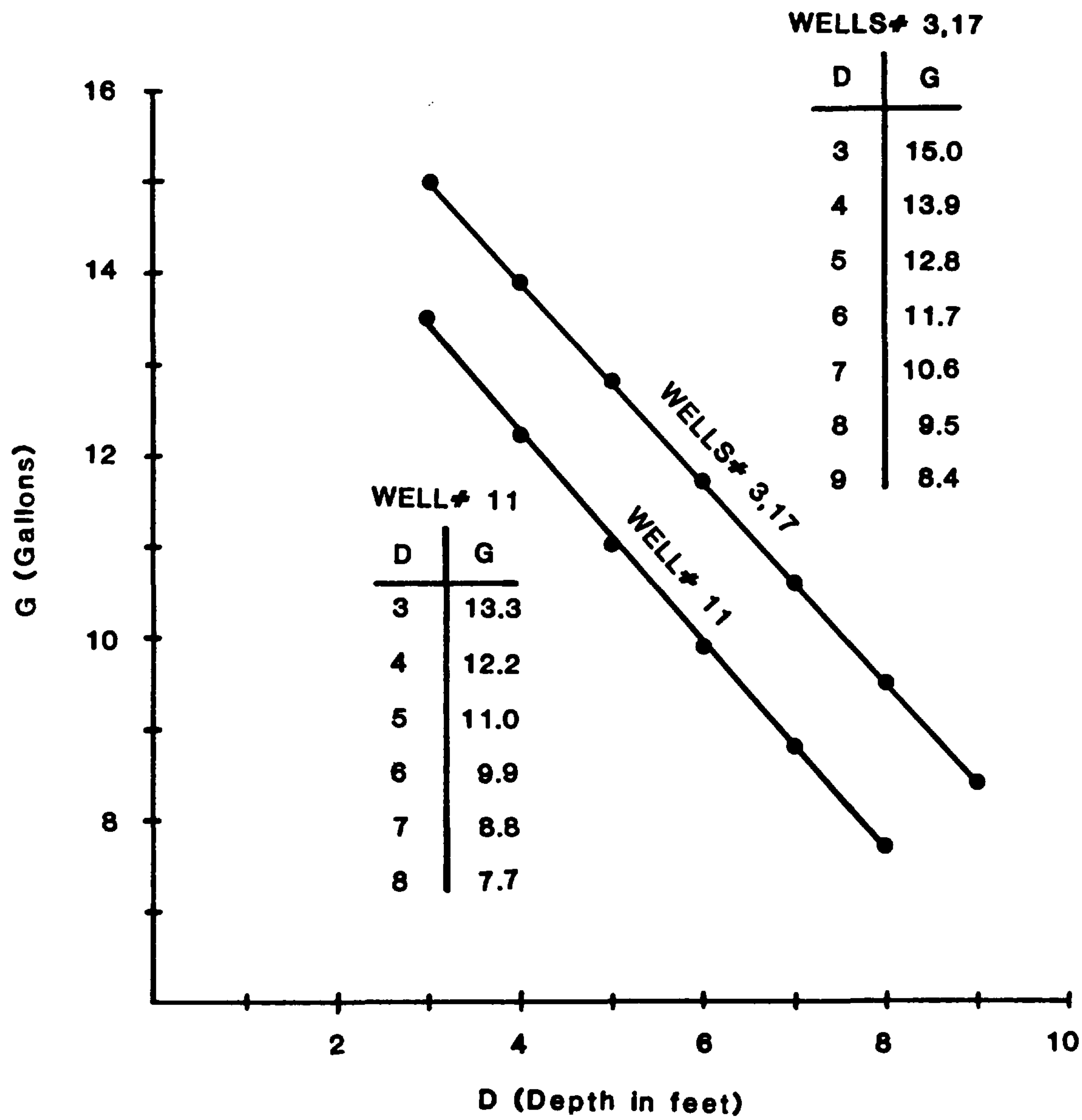
G– Gallons of liquid to be removed prior to sampling.

D– Depth of water level measured from top of riser.

In wells number 2 and 4 midpoint of screen 9.5' measured from top of riser.

In well number 1 midpoint of screen 10.5' measured from top of riser.

INFORMATION FOR WELLS NUMBER 3, 11 AND 17



WELLS# 3,17

D	G
3	15.0
4	13.9
5	12.8
6	11.7
7	10.6
8	9.5
9	8.4

WELL# 11

D	G
3	13.3
4	12.2
5	11.0
6	9.9
7	8.8
8	7.7

G– Gallons of liquid to be removed prior to sampling.

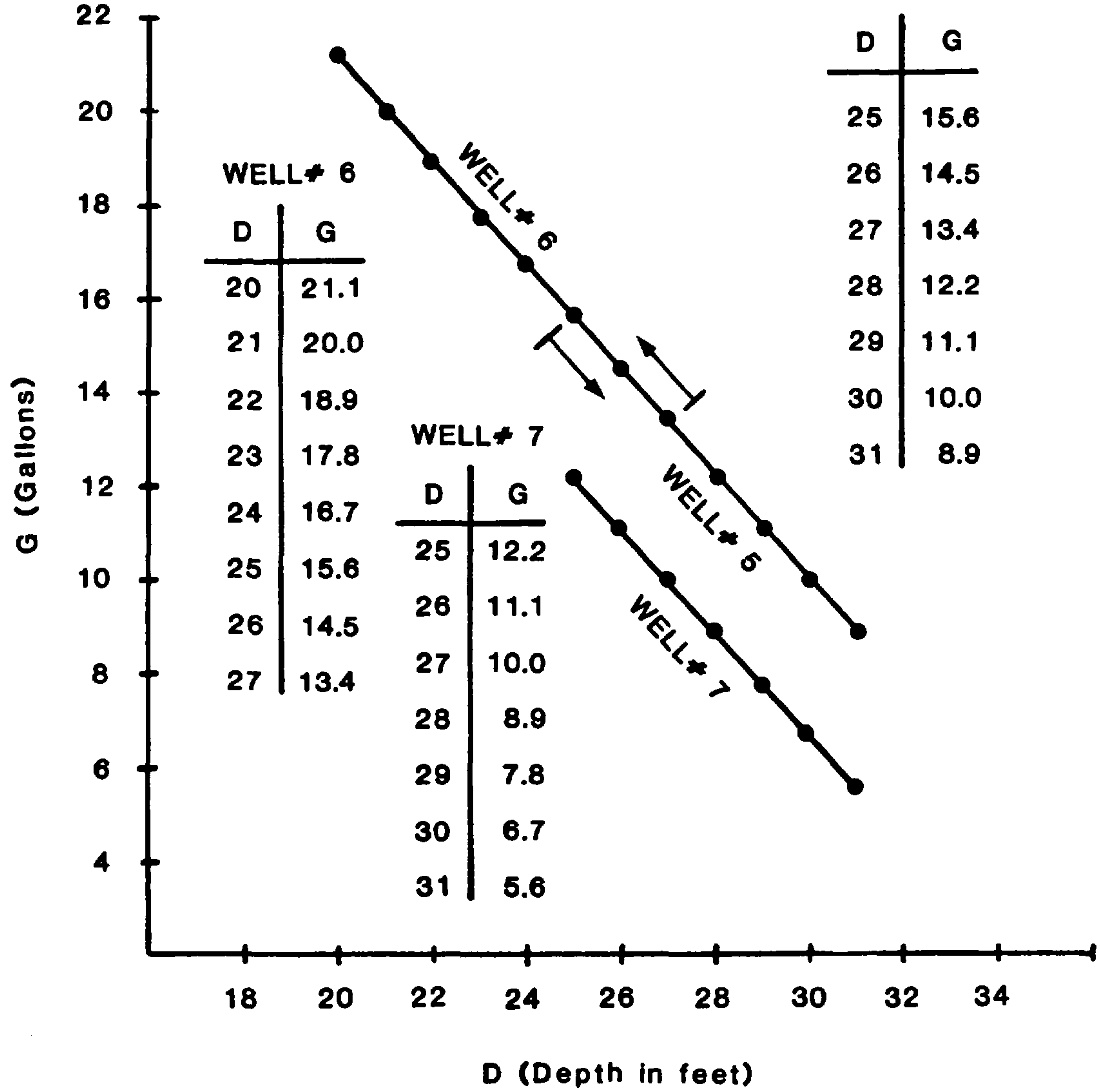
D– Depth of water level measured from top of riser.

In well number 3 midpoint of screen 6.2' measured from top of riser.

In well number 11 midpoint of screen 12.5' measured from top of riser.

In well number 17 midpoint of screen 13.7' measured from top of riser.

INFORMATION FOR WELLS NUMBER 5, 6 AND 7



WELL# 6

D	G
20	21.1
21	20.0
22	18.9
23	17.8
24	16.7
25	15.6
26	14.5
27	13.4

WELL# 7

D	G
25	12.2
26	11.1
27	10.0
28	8.9
29	7.8
30	6.7
31	5.6

WELL# 5

D	G
25	15.6
26	14.5
27	13.4
28	12.2
29	11.1
30	10.0
31	8.9

G– Gallons of liquid to be removed prior to sampling.

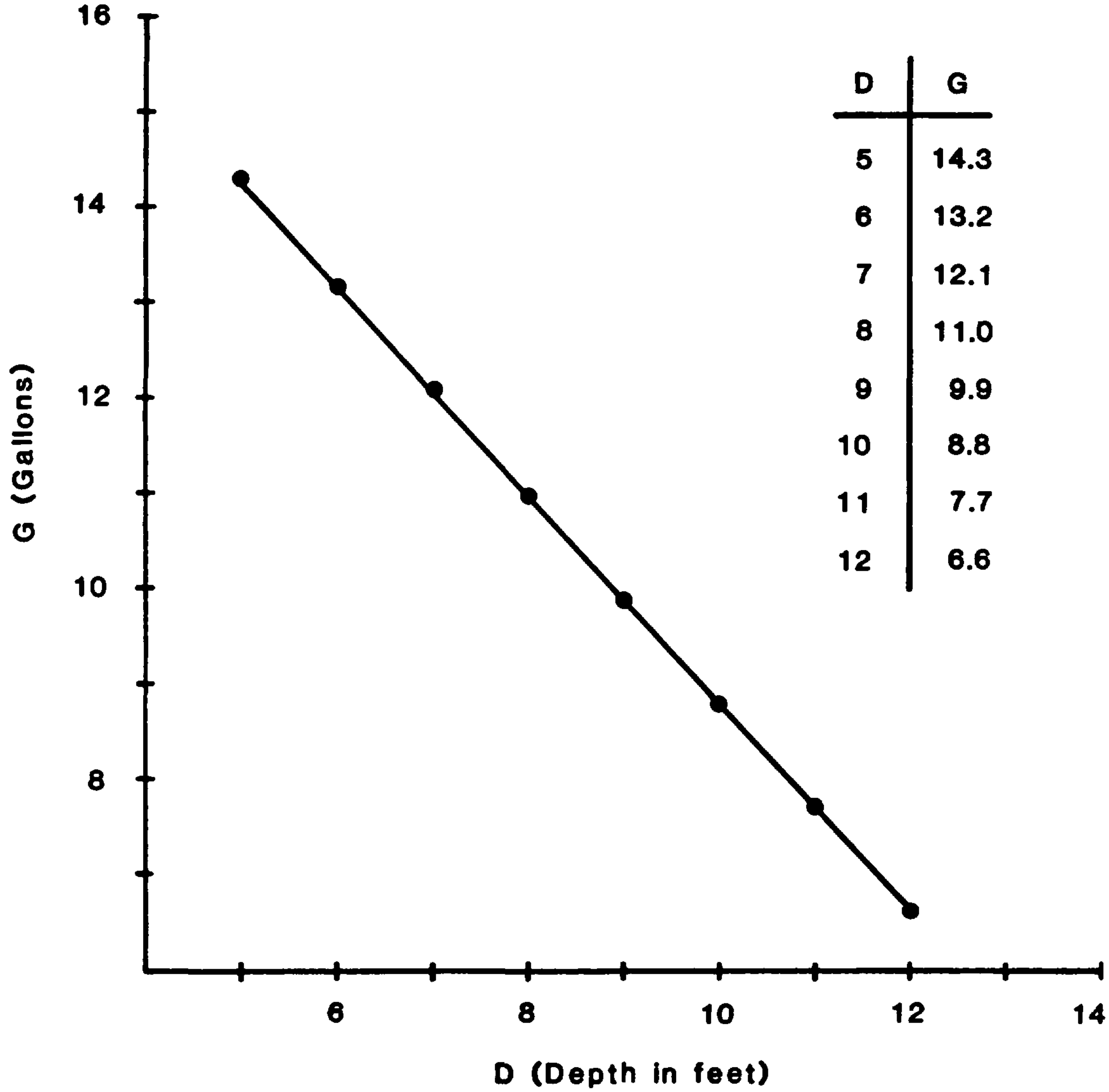
D– Depth of water level measured from top of riser.

In well number 5 midpoint of screen 36.5' measured from top of riser.

In well number 6 midpoint of screen 38.5' measured from top of riser.

In well number 7 midpoint of screen 33.5' measured from top of riser.

INFORMATION FOR WELLS NUMBER 8 AND 14



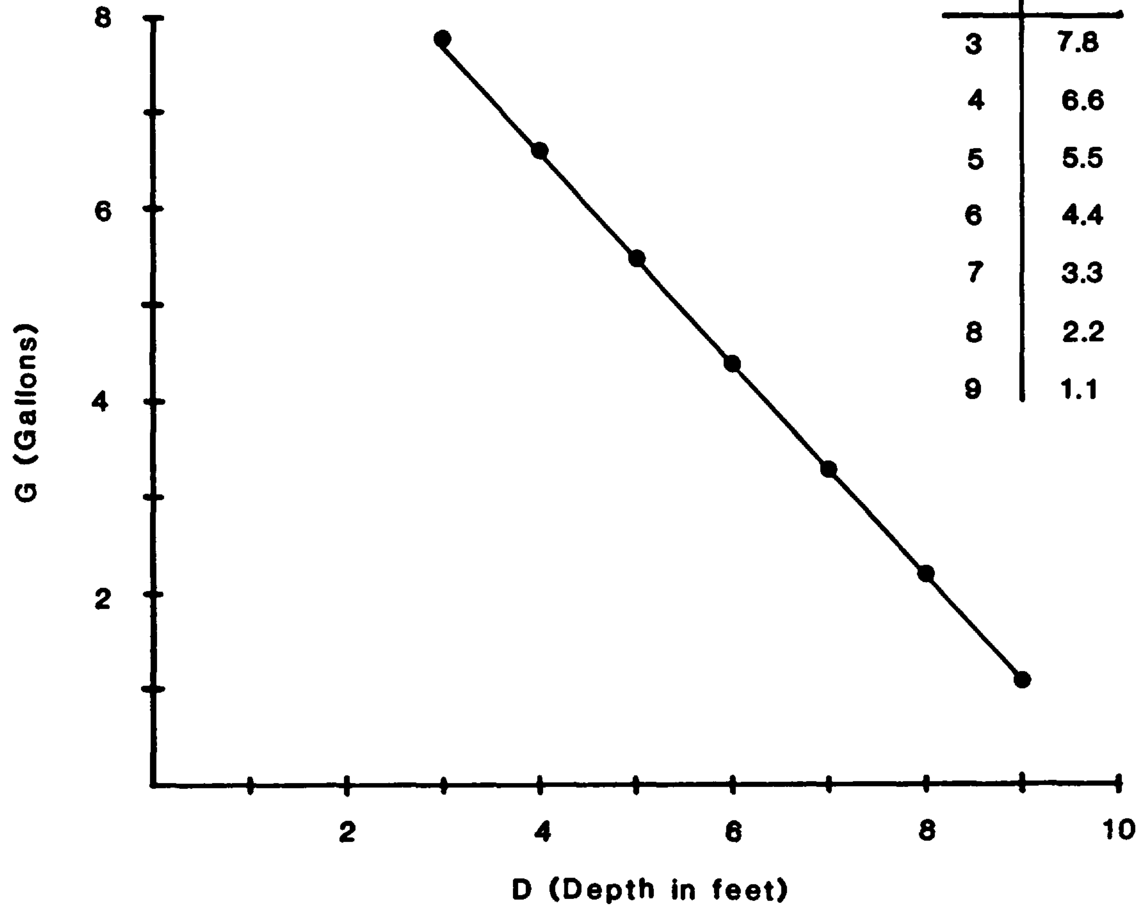
D	G
5	14.3
6	13.2
7	12.1
8	11.0
9	9.9
10	8.8
11	7.7
12	6.6

G– Gallons of liquid to be removed prior to sampling.

D– Depth of water level measured from top of riser.

In wells number 8 and 14 midpoint of screen 15.5′ measured from top of riser.

INFORMATION FOR WELLS NUMBER 9, 10, 12, 13, AND 13a



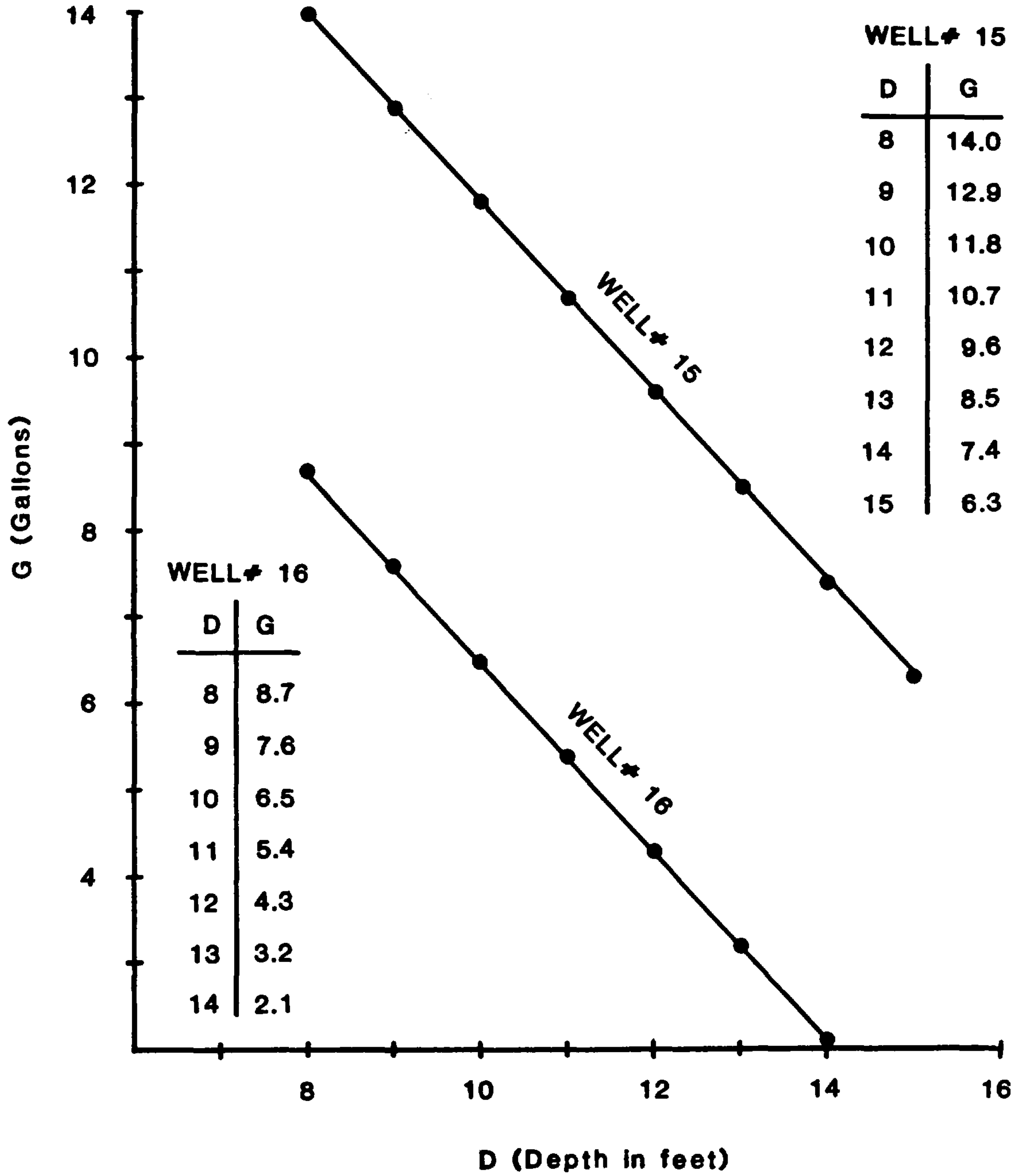
D	G
3	7.8
4	6.6
5	5.5
6	4.4
7	3.3
8	2.2
9	1.1

G– Gallons of liquid to be removed prior to sampling.

D– Depth of water level measured from top of riser.

In wells number 9, 10, 12, 13, and 13a midpoint of screen 7.5′ measured from top of riser.

INFORMATION FOR WELLS NUMBER 15 AND 16



WELL# 15

D	G
8	14.0
9	12.9
10	11.8
11	10.7
12	9.6
13	8.5
14	7.4
15	6.3

WELL# 16

D	G
8	8.7
9	7.6
10	6.5
11	5.4
12	4.3
13	3.2
14	2.1

G- Gallons of liquid to be removed prior to sampling.

D- Depth of water level measured from top of riser.

In well number 15 midpoint of screen 18.1' measured from top of riser.

In well number 16 midpoint of screen 18.3' measured from top of riser.

APPENDIX 3

Work Plans for Soil and Sediment Sampling
Conducted at the TRW Site
(In Chronological Order)

SAMPLING OF PCB CONTAMINATED SOILS AND SEDIMENTS AT THE MINERVA OHIO TRW PLANT

December 21, 1981

Submitted by:

Lowenbach and Schlesinger Engineering
A Division of Clement Associates, Inc.

INTRODUCTION

The TRW site at Minerva Ohio is shown in Figure 1; the area of contamination is based upon available sampling data. Though there are relatively few subsurface PCB concentration data available, these data indicate that PCB levels greater than 50 ppm are only found within the first foot of soil in Section A and B. In Section C, contamination is more extensive. The extent of contamination within the stream is unknown.

The following sampling plan outlines procedures for obtaining samples within three distinct areas of the Minerva site: the stream from the pond ending at Sandy Creek; Section B of the swale; and Section C of the swale. Section A of the swale will not be sampled further at this time.

SAMPLING PRECAUTIONS AND PROTECTIVE GEAR

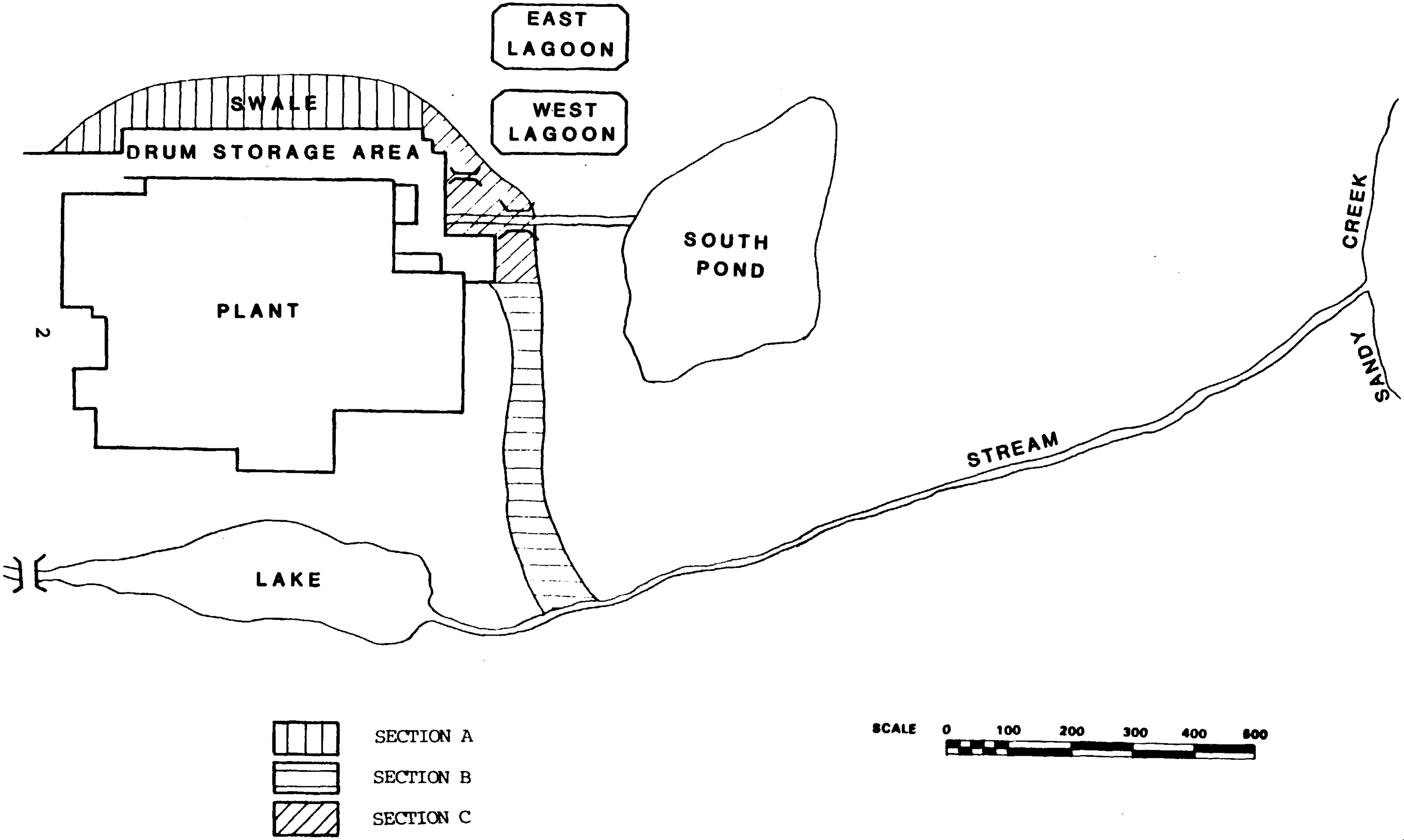
The following safety precautions must be observed when sampling PCB contaminated areas. The following protective gear must be worn at all times when sampling is being conducted:

- Tyvek suits
- Neoprene rubber gloves
- Rubber boots

SAMPLING PROCEDURES

One liter soil samples will be taken. Collected samples will be shipped to the analytical laboratory within two days after sampling.

Figure 1: SITE LAYOUT



Surface samples are to be taken with trowels. Samples at depths greater than 0.5 ft are to be taken using either an auger or hollow point core sampler. All samples shall be well mixed prior to emplacement in the sampling container. Sample shuttles (including decontaminated bottles) supplied by the ETC Corportaion are to be used for sample collection in Section C.

All samplers must be clean before use. Used samplers must be washed with water to remove adhering soil, rinsed with hexane, washed with a detergent solution (i.e., Liquinox or Alconox), rinsed with tap water, drained of excess water, and air dried, or dried with a stream of warm, dry air or wiped dry. Hexane washings may be regarded as hazardous and should be stored in closed waste containers.

CHAIN OF CUSTODY

Sample Labels

Sample labels (gummed paper labels or tags are adequate) must include the following information:

- Name of collector
- Date and time of collection
- Place of collection
- Collector's sample number, which uniquely identifies the sample

Sample numbers as noted within this document are to be used.

Sample Seals

Sample seals are used to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory. Gummed paper seals may be used for this purpose. The paper seal must include, at least, the following information:

- Collector's name
- Date and time of sampling
- Collector's sample number. (This number must be identical with the number on the sample label.)

The seal must be attached in such a way that it is necessary to break it in order to open the sample container.

Field Log Book

All information pertinent to a field survey and/or sampling must be recorded in a log book. This must be a bound book, preferably with consecutively numbered pages that are 21.6 by 27.9 cm (8 1/2 by 11 in.). Entries in the log book must include at a minimum, the following:

- Purpose of sampling (e.g., surveillance, contract number)
- Location of sampling point
- Name and address of field contact
- Type of waste (e.g., soil, sediment)
- Suspected waste composition including concentrations
- Number and volume of sample taken
- Description of sampling point and sampling methodology
- Date and time of collection
- Collector's sample identification number(s)
- Sample distribution and how transported (e.g., name of laboratory, UPS, Federal Express)

- References such as maps or photographs of the sampling site
- Field observations

The log book must be protected and kept in a safe place.

<u>Chain of Custody Record</u>

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record must be filled out and accompany every sample. This record is essential if the sample is to be introduced as evidence in a court litigation.

The record must contain the following minimum information:

- Collector's sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Waste time
- Signatures of persons involved in the chain of possession.
- Inclusive dates of possession

SAMPLING LOCATIONS

<u>Stream</u>

The sampling of the <u>stream</u> is exploratory and may proceed in stages

(a) From the end of the swale to 600 ft down the stream, draw samples according to the following scheme, choosing the distance from the middle of the stream to give maximum sedimentation:

DEPTH (ft)	FREQUENCY	NO. SAMPLES
0-1	1/20 ft	30
1-5 (randomize)	1/40 ft	15
5-10 (randomize)	1/100 ft	6
		51

(b) Exact positions down the stream and depths for sampling have been randomly selected within the strata defined above. The results are given in Table I.

(c) If there is evidence of contamination below the surface (1 ft) or at the far end of the sampled area, additional sampling may be required.

Section B of Swale

The existing sampling data for Section B (narrow swale down side of factory, position 900-1440 ft) are very sparse and non-uniformly distributed.

(a) Stratify this section of the swale into lengths (position) for shallow (0-5 ft) and deep (5-10 ft) sampling:

DEPTH (ft)	FREQUENCY	NO. OF SAMPLES
0-5 (randomize)	1/20 ft	27
5-10 (randomize)	1/50 ft	11
		38

(b) Six of the position strata (900-920, 980-1000, 1160-1180, 1180-1200, 1240-1260, and 1420-1440) have already been adequately sampled in the shallow range, reducing the number of samples to be drawn now to 32.

TABLE I

EXACT LOCATIONS OF
SAMPLING POINTS ALONG STREAM

SAMPLE NO.	DISTANCE DOWN STREAM (ft)	DEPTH (ft)	WIDTH* (ft)
1001	4.5	1.5	
1002	16.0	9.5	
1003	17.5	0.5	
1004	28.0	0.5	
1005	45.5	0.5	
1006	69.0	0.5	
1007	75.5	2.5	
1008	86.0	0.5	
1009	108.0	2.5	
1010	119.0	0.5	
1011	121.5	0.5	
1012	132.0	3.5	
1013	152.0	0.5	
1014	154.0	9.5	
1015	161.0	0.5	
1016	188.0	1.5	
1017	200.0	0.5	
1018	208.0	4.5	
1019	212.0	0.5	
1020	239.5	0.5	
1021	245.5	1.5	
1022	253.0	0.5	
1023	266.5	0.5	
1024	279.0	7.5	
1025	295.5	3.5	
1026	300.0	0.5	
1027	311.0	0.5	
1028	316.0	5.5	
1029	321.0	3.5	
1030	331.5	0.5	
1031	349.0	0.5	
1032	365.5	4.5	
1033	374.0	0.5	
1034	390.0	0.5	
1035	402.0	1.5	
1036	412.5	0.5	
1037	429.0	0.5	
1038	442.5	4.5	
1039	446.0	6.5	
1040	453.0	0.5	
1041	475.0	0.5	
1042	481.0	0.5	

TABLE I (concluded)

EXACT LOCATIONS OF
SAMPLING POINTS ALONG STREAM

SAMPLE NO.	DISTANCE DOWN STREAM (ft)	DEPTH (ft)	WIDTH* (ft)
1043	485.5	3.5	
1044	504.0	7.5	
1045	511.0	0.5	
1046	533.5	0.5	
1047	544.0	2.5	
1048	552.0	0.5	
1049	567.0	0.5	
1050	583.5	2.5	
1051	592.5	0.5	

*Distance from mid-stream will be selected on site to give the spot with maximum sedimentation and will record as + or - the number of feet east or west, respectively, of mid-stream.

(c) The exact positions and depths for sampling have been randomly selected within the strata defined in section (a), excluding those indicated in section (b). Distances from midline of the swale were selected randomly from a uniform distribution over -20 ft to +20 ft where "-" indicates south and "+" north of the midpoint of the swale. The results are given in Table II.

<u>Corner Section of Swale</u>

Further sampling of the <u>corner section</u> for PCBs and other chemicals, particularly polychlorinated di-benzo furans.

(a) The area to be sampled is shown in Figure 2. A grid is defined by dropping a line from the lower right hand corner of the dock, through the top most corner, for a total length of 300 ft and then extending perpendiculars from these end points out 167 ft. The 167 ft are divided into five bands 33.3 ft wide. Sampling strata one foot thick are defined: six for the band closest to the building, five in the next, ..., two in the one farthest away, to approximate the wedge-shaped volume that will be removed. (If sample points are chosen in the sections of the dock sticking into the first band the samples will be drawn in the areas outside of the grid by rotating the triangular areas as indicated by the arrows on the map.) This defines 20 strata from each of which a sample will be drawn by randomly selecting a point between 0 and 300 ft and another point between 0 and 33.3 ft.

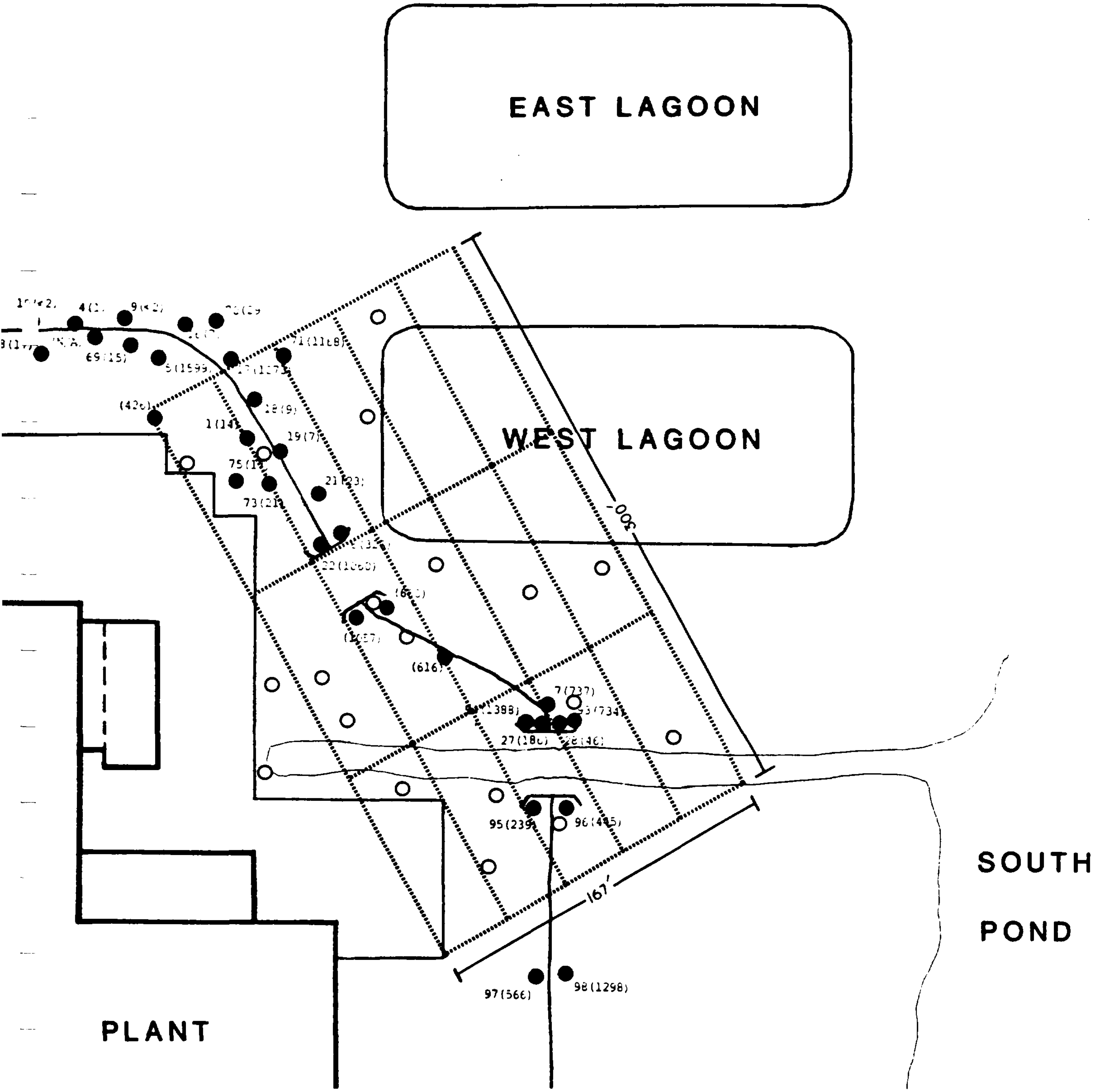
TABLE II

EXACT LOCATIONS OF SAMPLE POINTS IN SWALE SECTION B

SAMPLE NO.	POSITION DOWN SWALE* (ft)	DEPTH (ft)	DISTANCE FROM MID-SWALE** (ft)
2001	919.0	6.5	+11.0
2002	929.5	4.5	-13.5
2003	958.5	1.5	-18.0
2004	973.0	0.5	+19.0
2005	991.5	7.5	+ 5.0
2006	1015.5	1.5	- 2.0
2007	1028.0	8.5	+14.0
2008	1031.0	4.5	-13.0
2009	1044.0	0.5	+ 2.0
2010	1082.0	7.5	+18.5
2011	1112.5	4.5	- 8.5
2012	1121.0	5.5	+12.5
2013	1134.5	1.5	0.0
2014	1155.0	2.5	-17.0
2015	1156.5	8.5	-11.5
2016	1164.5	0.5	-11.0
2017	1214.5	3.5	+10.0
2018	1233.0	2.5	-11.0
2019	1239.5	9.5	+18.5
2020	1256.5	2.5	- 2.0
2021	1259.0	5.5	+17.0
2022	1264.0	1.5	+17.5
2023	1292.5	4.5	-17.0
2024	1307.0	3.5	- 3.5
2025	1323.0	1.5	+ 5.5
2026	1334.0	8.5	+ 0.5
2027	1352.5	3.5	-10.0
2028	1370.0	0.5	+ 0.5
2029	1382.5	6.5	- 7.5
2030	1387.0	2.5	+14.5
2031	1411.0	4.5	- 1.0
2032	1432.0	5.5	-12.5

*As used in previous sampling

**+ = north of mid-swale; - = south of mid-swale



● 96(415): EXISTING SAMPLE POINT NUMBER (PCB in ppm)

○ : PROPOSED SAMPLE POINTS

FIGURE 2. CORNER SECTION OF SWALE

(b) The random selected positions of the 20 sampling points are given in Table III. The approximate locations of these points are marked on a second copy of the map.

TABLE III

EXACT LOCATIONS OF SAMPLE POINTS IN CORNER AREA

SAMPLE NUMBER	BAND	DEPTH (ft)	DISTANCE FROM BOTTOM LINE (0-300 ft)	DISTANCE FROM EDGE OF BAND NEAR BUILDING (0-33.3 ft)
3001	1	0.5	275.0	7.0
3002		1.5	121.0	-34.5
3003		2.5	81.0	25.0
3004		3.5	146.0	12.0
3005		4.5	157.0	- 9.0
3006		5.5	126.5	12.5
3007	2	0.5	54.0	29.5
3008		1.5	30.0	2.5
3009		2.5	154.5	30.0
3010		3.5	268.0	5.0
3011		4.5	171.0	19.5
3012	3	0.5	170.5	27.0
3013		1.5	246.0	30.5
3014		2.5	116.0	0.0
3015		3.5	36.5	5.0
3016	4	0.5	287.5	20.0
3017		1.5	86.5	16.5
3018		2.5	133.0	25.0
3019	5	0.5	125.0	23.0
3020		1.5	23.0	12.5

COMPREHENSIVE SAMPLING PLAN FOR PCB CONTAMINATED SOILS AND SEDIMENTS AT THE TRW, MINERVA SITE

Prepared for

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September 9, 1982

Introduction

The TRW, Minerva, site is depicted in Figure 1. Previous sampling data indicate that portions of the site are contaminated with PCB from a protracted spill. This sampling plan is designed to assess the extent of contamination and identify transport mechanisms that may facilitate migration of PCB from the site.

The two most likely routes of PCB migration are via groundwater and surface water. In the first case, PCBs from contaminated soils on site are transported vertically by percolation until they reach the water table. Contamination then spreads horizontially with groundwater movement. In the second case, precipitation runoff transports contaminated soil particles into local lakes and streams where the particles are carried further downstream by surface water currents. Both of these migration routes and related phenomena are considered in this sampling plan.

Six contaminated areas and areas of potential contamination are to be sampled to assess the extent of contamination: the swale, the wax ditch, the south pond and berm, the southeast rubble pile, the west lake and stream system, and the Fry property. Though sampling will focus on these areas, it need not be limited to these sites. The sampling program has been prioritized to maximize efficiency because information obtained in earlier parts of the sampling program will be used to modify later sampling plans. An outline of the program is presented in Table 1.

Figure 1: SITE LAYOUT

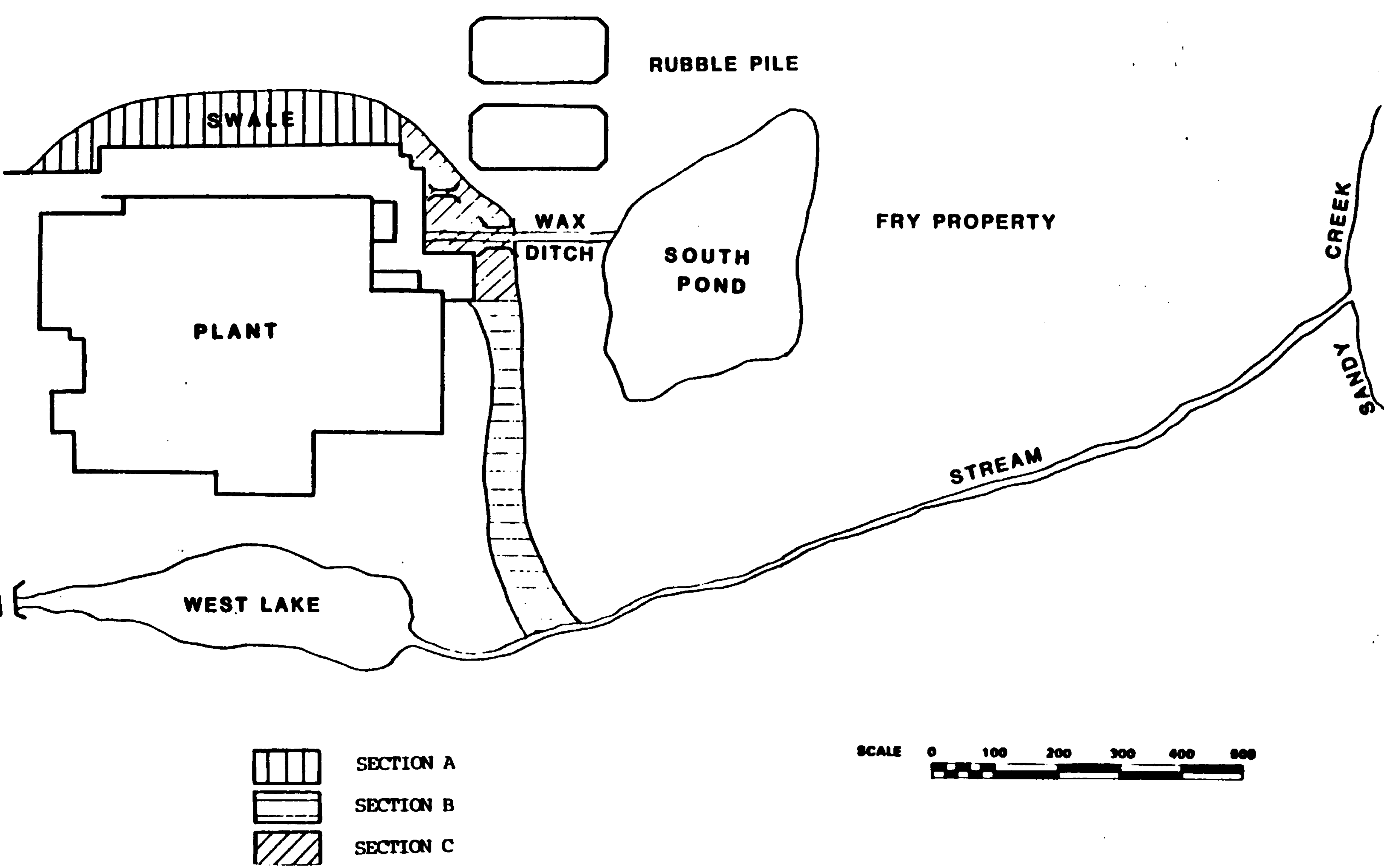


TABLE 1: SAMPLING SCHEME FOR MINERVA

Site	Sample Description	Number of Samples Priority 1	2	3	4
Swale	Deep core			62	
Wax ditch	Core and surface		40		
South Pond	Berm	10			
	Sediment core				32
Rubble Pile	Preliminary	32			11
Lake and Stream	Exploratory	30			
Fry Property	Core	8			
	Water	2			
	Core and grid				46
Other	Core and surface		22		
	Total	82	62	62	89
	Total samples = 295				

Sampling Procedure

One-liter soil samples will be taken. Collected samples will be shipped to the analytical laboratory within two days after sampling. Individual samples will be homogenized before analysis.

Surface samples are to be taken with trowels. Samples at depths greater than 0.5 feet are to be taken using either an auger, hollow point core or split spoon sampler. All samples shall be well mixed before emplacement in the sampling container.

All samplers must be clean before use. Used samplers must be washed with water to remove adhering soil, rinsed with hexane, washed with a detergent solution (i.e., Liquinox or Alconox), rinsed with tap water, drained of excess water, and air dried or dried with a stream of warm, dry air. Hexane washings may be regarded as hazardous and should be stored in closed waste containers.

Sample points are to be marked with wooden stakes bearing the sampling location number. Stakes may be placed in the core and secured by backfilling the core with soil or bentonite. (In areas where sample markers are likely to impede mowing or other activities, stakes should remain flush with the surrounding material.)

Cores deeper than 2 feet must be backfilled with bentonite. (In low-lying areas, all cores except surface scrapes should be backfilled with bentonite.) Briefly, the core is backfilled with bentonite pellets 1 foot at a time. After each foot of bentonite is added, a quantity of water equal to 10% of the clay volume is poured over the added clay to promote swelling. The process is then repeated until the core is filled.

Samples will be collected, stored, and transported in a manner ensuring the chemical integrity of the sample until analysis can be performed. The following protocols will be incorporated into the sample handling procedure.

A. Sample Labels

Sample labels (gummed paper labels or tags are adequate) must include the following information:

- Name of collector
- Date and time of collection
- Place of collection
- Collector's sample number, which uniquely identifies the sample.

Sample numbers as noted within this document are to be used.

B. Sample Seals

Sample seals are used to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory. Gummed paper seals may be used for this purpose. The paper seal must include, at least, the following information:

- Collector's name
- Date and time of sampling
- Collector's sample number (identical with the number on the sample label)

The seal must be attached so that it is necessary to break it in order to open the sample container.

C. Field Log Book

All information pertinent to a field survey and/or sampling must be recorded in a log book. This must be a bound book, preferably with consecutively numbered pages that are 21.6 by 27.9 cm (8.5 by 11 inches). Entries in the log book must include at a minimum, the following:

- The sampler's name and address

- The sampling methodology
- The time and date each sample was collected
- The nature of the sample (e.g., soil, sediment, wax residue)
- Relevant observations (odors, colors, moisture, etc.)
- The sampling location
- A description of the sampling location
- references such as maps or photographs of the sampling site.

Sampling locations should be reported with an accuracy of 1 foot, and depths with an accuracy of 0.5 feet. Distances denoted in tables represent the middle value of these increments (e.g., a 1.0-foot depth means the sample is at a depth lying between 0.5 and 1.5 feet.) The log book must be protected and kept in a safe place.

D. Chain of Custody Record

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record must be filled out and accompany every sample. This record is essential if the sample is to be introduced as evidence in litigation.

The record must contain at least the following information:

- Collector's sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Tenure of possession

- Signatures of persons involved in the chain of possession
- Inclusive dates of possession.

Sampling Precautions and Protective Gear

Proper safety precautions must be observed when sampling PCB-contaminated areas. Accordingly, the following protective gear must be worn at all times when sampling is being conducted:

- Tyvek suits
- Neoprene rubber gloves
- Rubber boots

All equipment removed from the site must be decontaminated or disposed of in an appropriate manner.

Sampling Locations

To facilitate sample collection and reporting, sampling plans will be generated from a master sampling map that also depicts all previous sampling results. Sampling plans will be accompanied by grid maps (broken into 50-foot square sectors) depicting suggested sampling locations. Results should be returned accompanied by similar grid maps denoting actual sampling locations. These maps will be used to update the master sampling map.

For convenience, all major plant walls, property lines, fence lines, and other borders at the site are assumed to lie along north-south and east-west axes, though this is not actually the case. (Magnetic north is 10° east of the north designated.) Such a designation presents no problems, though it does facilitate gridding of the site. Thus, all further references to site locations will incorporate this assumption.

Two reference points were established on the site to locate grids. Reference point A lies 350 feet west of the eastern property fence boundary on a line that includes the southern boundary of the two lagoons. (Reference point A is 333 feet north of the south fence.) Grids denoting sampling points in south pond and the rubble pile are centered at reference point A. Reference point B lies 100 feet east of the southwest corner of the plant (575 feet north of the south fence). Grid maps denoting sampling points in west lake are centered at reference point B. Other reference points may be generated as the need arises.

Sampling Program

Suggested sampling locations for the Minerva site are detailed in the following program. Sampling plans for specific sites are grouped into four priority categories to facilitate sample collection.

Priority 1

Sampling described in this section should be performed first. Much of the information derived from priority 1 sampling will be used to modify lower priority sampling plans.

A. South pond and berm (Total of 10 samples)

The retaining berm for south pond is composed of debris similar to the southeast rubble pile. To determine if this material is contaminated, 10 samples will be collected at random locations distributed along the entire length and height of the berm. Samples will be numbered consecutively beginning with 501. Half of the samples will be surface samples and half will be collected at varying depths between 1 and 4 feet (randomized). Because the berm is a heterogeneous mass, documentation of surface samples in this area should include a description of the nature of the material being sampled in addition to the depth of the sample. Actual sample locations should be marked on the south pond grid map supplied for this purpose (Figure 2). Sample locations should also be recorded on Table 2 ("S" denotes surface samples).

Core samples of south pond sediment will not be obtained at this time. Voids left from removing core samples cannot easily be sealed under water; therefore sampling could introduce an additional path for PCB migration. Thus, core sampling of south pond sediment will be delayed at least until sufficient groundwater data have been obtained to allow detection of new migration.

B. <u>Southeast rubble pile</u> (Total of 32 samples)

The southeast rubble pile is composed of debris generated from numerous plant modifications over the years. The pile must be sampled because it represents a potential point source of contamination.

Priority 1 sampling of the rubble pile is preliminary. Thirty-two samples will be collected to determine the extent

FIGURE 2 SOUTH POND

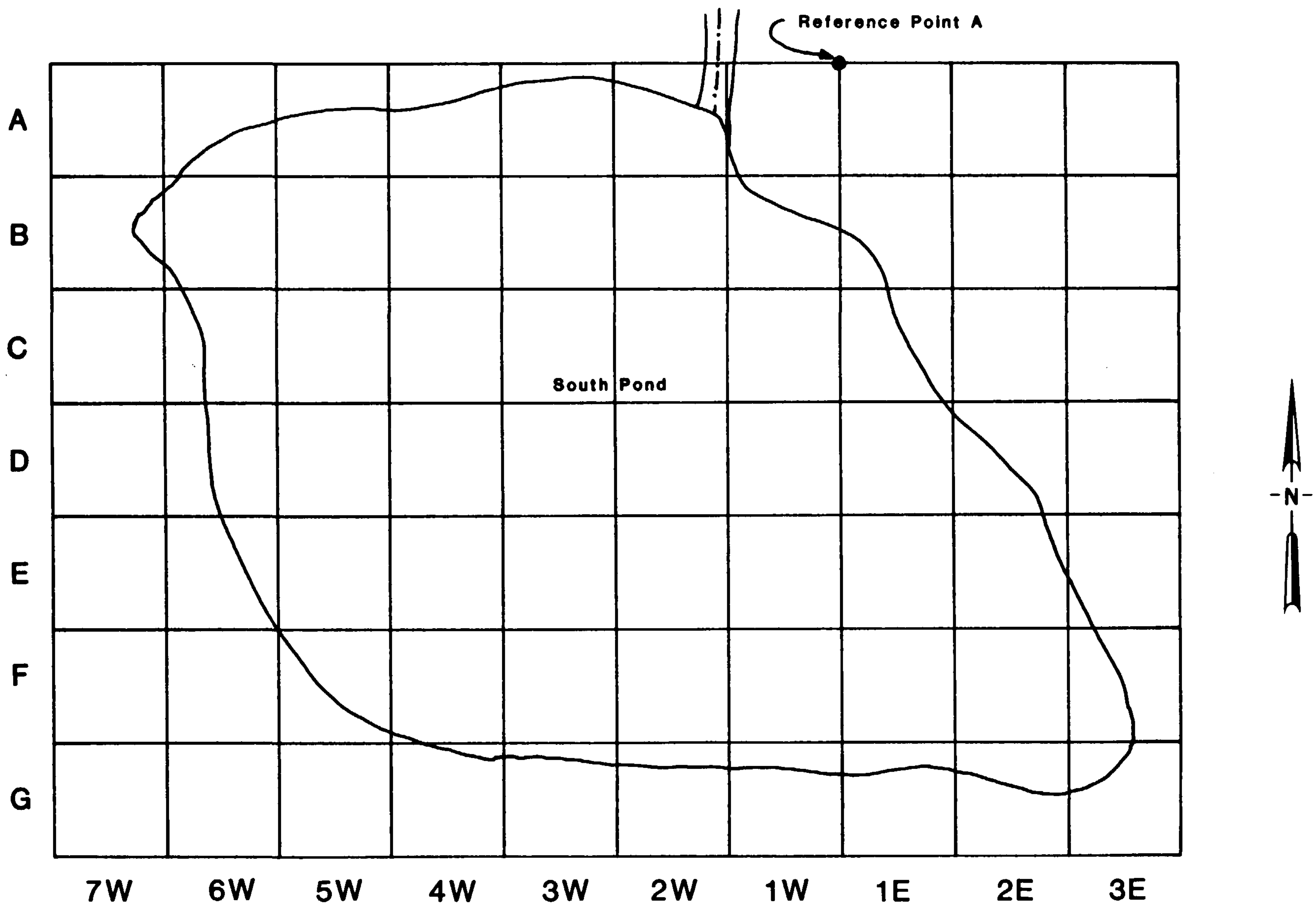


TABLE 2

LOCATIONS OF SOUTH POND BERM SAMPLES

Sample Number	Sector	Distance South of Ref. Pt. A	Distance East of Ref. Pt. A	Depth
501				S[a]
502				1.5 ft
503				S
504				S
505				1.5 ft
506				S
507				2.5 ft
508				1.0 ft
509				3.5 ft
510				S

(Locations will be selected on site)

[a]Surface samples must be collected within the top 0.5 ft of material.

of contamination in the pile and identify potential PCB migration pathways. Sample locations are denoted on Figure 3. Sample locations were generated by picking critical sectors to be sampled and placing a sampling point at random within each critical sector. The depths of the samples to be taken at each location are presented in Table 3 ("S" denotes surface samples). Note that more than one sample is to be collected at several locations.

Samples 531 through 534 are surface samples. These should be collected along paths were erosion is visible, but specifically at low points in these paths where contaminated sediment is likely to collect. The first two of these samples will be

APPENDIX 2

a. Work Plans for the Installation of Monitoring Wells Already Present at the TRW Site

b. Work Plan for Establishing Groundwater Sampling Protocols for PCBs

Installation of the First 18 Monitoring Wells in 1982

FIGURE 3 RUBBLE PILE

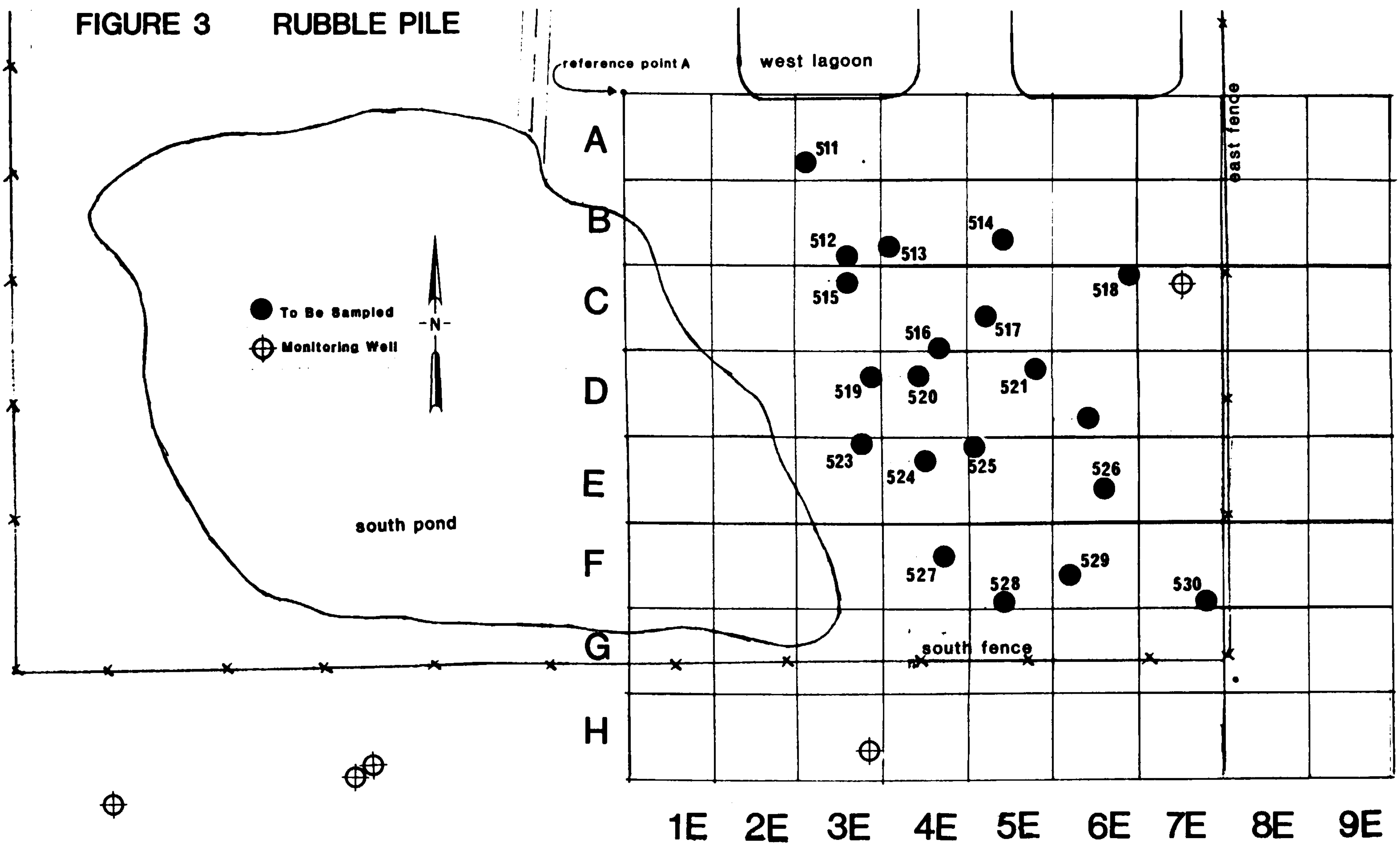


TABLE 3

LOCATIONS OF RUBBLE PILE SAMPLES

Sample Number	Sector	Distance South of Ref. Pt. A	Distance East of Ref. Pt. A	Depth
511a	A3E	40 ft	105 ft	S[a]
511b				1.5 ft
512	B3E	95 ft	130 ft	S
513a	B4E	90 ft	150 ft	S
513b				1.5 ft
514	B5E	85 ft	220 ft	S
515	C3E	110 ft	130 ft	S
516	C4E	150 ft	185 ft	S
517	C5E	130 ft	210 ft	S
518a	C6E	105 ft	295 ft	S
518b				1.5 ft
519	D3E	165 ft	145 ft	S
520a	D4E	165 ft	170 ft	S
520b				1.5 ft
521	D5E	160 ft	240 ft	S
522	D6E	190 ft	270 ft	S
523	E3E	200 ft	140 ft	S
524	E4E	215 ft	175 ft	S
525a	E5E	205 ft	200 ft	S
525b				1.5 ft
526a	E6E	230 ft	280 ft	S
526b				1.5 ft
527	F4E	270 ft	185 ft	S
528a	F5E	300 ft	220 ft	S
528b				1.5 ft
529	F6E	280 ft	260 ft	S
530a	F7E	295 ft	340 ft	S
530b	F7E	295 ft	340 ft	1.5 ft
531 In Row H (see notes)				
532				
533 In columns 7 or 8 (see notes)				
534				

[a]Surface samples must be collected within the top 0.5 ft. of material.

obtained from the Fry property in the vicinity of grid row H. The second two samples will be collected in columns 7 or 8 to detect potential eastward migration of PCB. Locations of these samples should be denoted on a copy of Figure 3 and Table 3.

Because the rubble pile is a heterogeneous mass, documentation of samples in this area should include a description of the nature of the material sampled. The extent of PCB contamination should be determined for each component material of the pile independently. Thus, homogeneous samples of each material component present in the rubble pile (i.e., concrete, soil, wax residue, etc.) should be included among the 32 samples to be obtained at this site. (Note: changes in sample locations for this or any other purposes should be denoted on the grid map Figure 3 and Table 3).

C. <u>West lake and stream system</u> (Total of 30 samples)

The west lake and stream system represents a potential pathway where PCB may migrate via surface runoff. Sediment contaminated with PCB may be washed into this system from other sources by precipitation. Currents would then carry the contaminated sediment downstream. Three sections of this system will be sampled: the forks of the stream upcurrent from the plant, west lake, and the stream flowing out of west lake toward Sandy Creek. (Note: to minimize interference, samples furthest downstream should be collected first and sampling should proceed upstream.)

The five locations for collecting surface sediment upstream are depicted in Figure 4. The locations depicted serve only as rough guides, however. Samples should be obtained where heavy sedimentation is apparent (i.e., bends in the stream or upstream from large rocks). Actual sampling locations should be denoted on Figure 4 and a suitable table. Samples should be numbered from 535 to 539 inclusive.

Five sediment samples will be obtained from west lake. These surface sediment samples should be obtained in areas where sedimentation appears heaviest. (The locations depicted on the map are rough guides only.) Actual sampling locations should be denoted on the grid in Figure 5. Samples should be numbered from 540 to 544 inclusive.

The stream will be sampled from the end of the swale to a distance 600 feet downstream. Twenty samples are to be collected according to the following scheme:

Depth (feet)	Frequency	Number of samples
0-1	1/40 feet	15
1-5	1/120 feet	5
		20

Suggested positions down the stream and depths have been randomly selected within the strata defined above. Results are presented in Table 4. Samples should be collected where heavy sedimentation is apparent. Actual sample locations should be denoted on a copy of Table 4 and a suitable map.

FIGURE 4 UPSTREAM FORKS

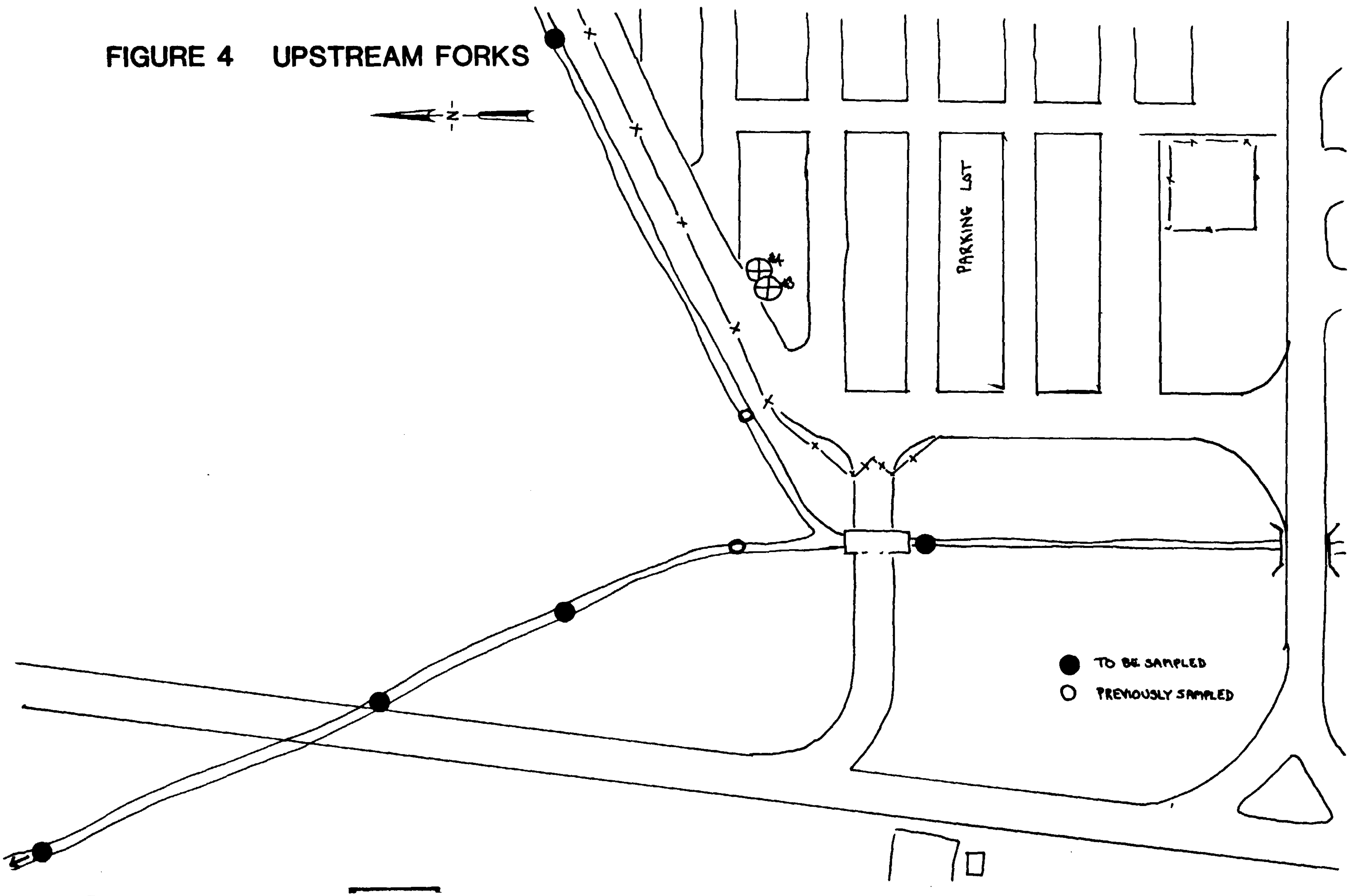


FIGURE 5 WEST LAKE

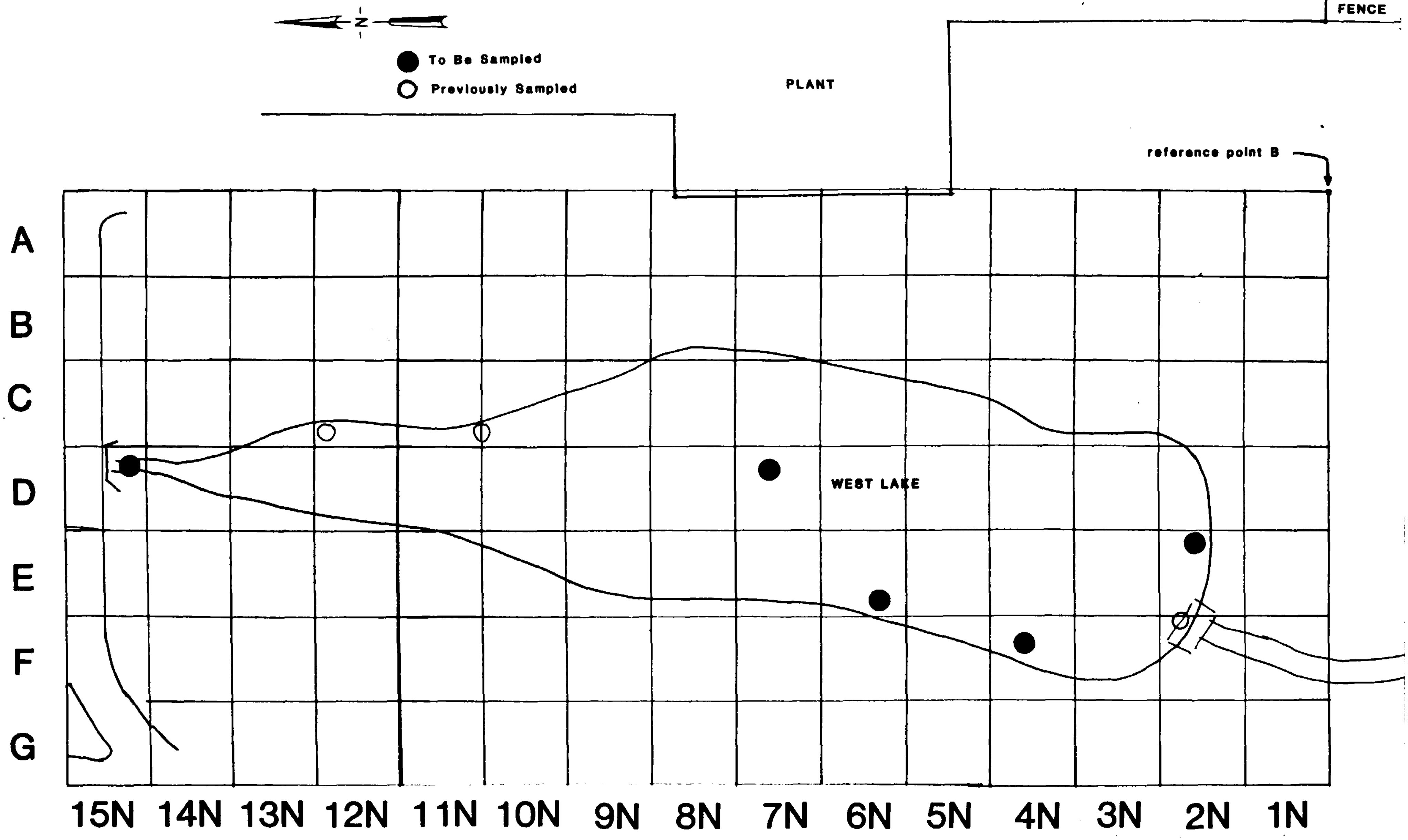


TABLE 4

SUGGESTED LOCATIONS OF SAMPLES DOWNSTREAM OF SWALE

Sample Number	Distance from Swale[a] (ft)	Depth (ft)	Width[a] (ft)
545	3.5	1.0	
546	17.5	3.5	
547	70.0	S[b]	
548	106.0	1.0	
549	132.0	1.0	
550	178.5	3.0	
551	206.0	4.5	
552	245.5	S	
553	289.5	S	
554	311.0	S	
555	331.5	4.5	
556	364.5	1.0	
557	412.0	S	
558	426.0	S	
559	453.5	S	
560	481.0	1.5	
561	485.5	S	
562	530.5	1.0	
563	567.0	S	
564	591.5	S	
565	600.0	1.0	

[a](Exact locations to be selected on site)

[b]Surface samples must be collected within the top 0.5 feet of material.

D. Fry property (Total of 11 samples and 2 water samples)

Monitoring well core samples will be analyzed to provide an indication of the extent of PCB contamination with depth. All three core samples from well No. 10, all five from well No. 11, and all three from well No. 13 should be analyzed for this purpose. PCB concentrations should be reported as a function of depths for these three sites. Results of this analysis will serve as a guide for further sampling of the Fry property.

The sausage pond on the Fry property may represent an important indicator of groundwater condition. Since it lies in a low area and is likely to articulate with groundwater, the pond may serve as a sensitive barometer of groundwater contamination. Duplicate analysis of the water in sausage pond should be performed. (Though the pond has already been sampled, it should be resampled in a manner suitable for detecting PCB at a concentration of 20 ppt.)

Priority 2

The principal objectives of Priority 2 sampling are to determine the level of contamination in the wax ditch and to measure background contamination for the site in general.

A. The Wax Ditch (total of 40 samples)

Discarded casting wax and other plant wastes were dumped in the wax ditch. Several of these materials are likely to be contaminated with PCB. The wax ditch also represents the most probable source of the contamination in south pond. Sampling in the wax ditch will establish the level of contamination in the ditch and identify PCB migration routes from the ditch to other areas. Potential routes include horizontal surface transport and vertical percolation into the ground.

Ten surface samples and thirty core samples will be collected at random locations distributed along the length of the wax ditch according to the following scheme:

Depth (ft.)	Frequency	Number of Samples
S	1/30 ft.	10
1-5	1/12 ft.	25
8-10	1/60	5
		40

where "S" represents surface samples. Suggested sample depths and locatons are presented in Table 5.

If changes are required for any reason, actual sample depths and locations should be recorded on a copy of Table 5.

Two distinct layers of material will be sampled in the wax ditch: a waxy residue consisting largely of materials dumped into the ditch and the underlying soil material of the ditch. Since the extent of contamination should differ in each of these materials, the residue and soil in the ditch should be sampled independently. Thus sample depths listed in Table 5 should be adjusted on site to avoid collection of samples containing a mixture of residue and soil. Cores containing such a mixture should be discarded in the ditch, and a second core should be obtained from the same location at a sufficient depth so that the sample consists solely of soil material. The nature of the material actually sampled at each

TABLE 5

SAMPLING LOCATIONS FOR WAX DITCH

Sample Number	Distance from Cement Pad (ft)	Depth[b] (ft)	Width[a] (ft)
579	9	S	+0.0
580	27	2.0	-3.0
581	30	S	-2.5
582	36	4.0	-1.0
583	36	S	+3.0
584	39	2.0	-3.5
585	42	8.5	+2.0
586	54	1.0	-1.0
587	63	4.0	+1.0
588	66	S	-2.5
589	66	4.0	+3.0
590	72	2.5	-1.0
591	81	2.5	-4.5
592	84	S	-3.5
593	90	3.0	-1.5
594	99	1.0	0.0
595	102	9.5	-1.0
596	107	5.0	0.0
597	129	5.0	0.0
598	144	1.5	-3.5
599	150	S	-1.0
600	156	1.5	-1.0
601	171	8.0	+1.0
602	180	4.5	-3.0
603	189	1.0	-1.0
604	189	S	-2.5
605	198	1.5	-1.0
606	207	5.0	-4.0
607	210	S	+0.0
608	210	6.5	-4.0
609	213	1.5	-4.5
610	225	S	+1.0
611	225	4.5	-5.0
612	231	1.0	+3.0
613	234	4.0	+4.0
614	243	1.0	+2.0
615	279	3.0	-3.0
616	292	6.5	-2.0
617	295	S	+4.5
618	298	4.5	-2.0

[a]This number represents + or - the number of feet east or west, respectively, of the center line of the swale

[b]Surface samples must be collected within the top 0.5 feet of material

point should be recorded. Finally, cores of all samples collected in the wax ditch (except the 10 surface samples) should be backfilled with bentonite to minimize any possibility of accelerating PCB migration. Note: Cores should be collected only if the ditch is free of standing water.

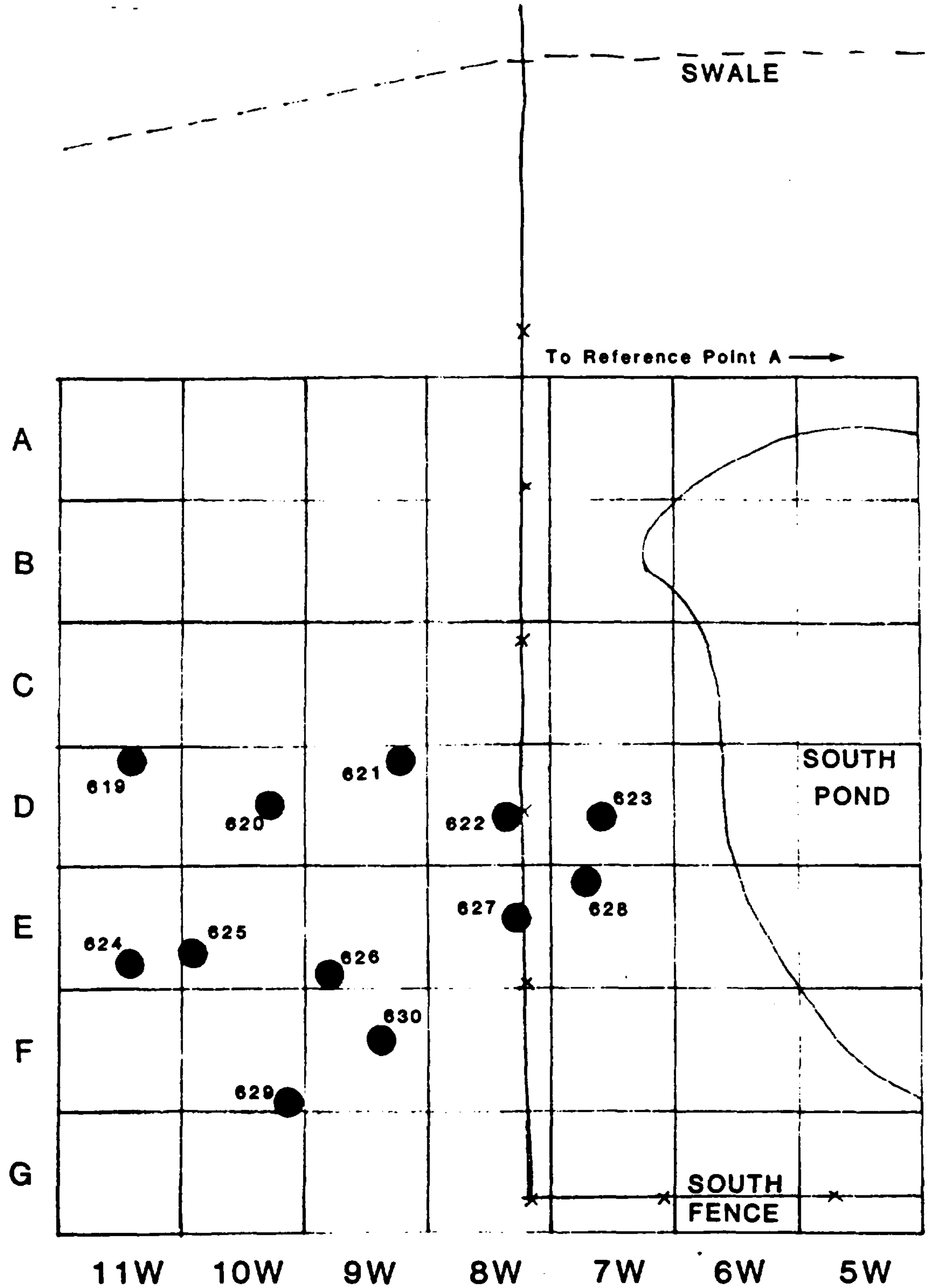
B. <u>Surrounding Area Samples</u> (total of 32 samples)

A preliminary assessment of the level of contamination will be performed for two regions not previously sampled. These regions are: (1) the low lying area in the field adjoining south pond and (2) the north property line of TRW. Contamination is expected to be insignificant at the latter site so that data obtained in this area may serve to establish background contaminant levels.

Priority 2 sampling of the low lying area is preliminary. Twelve samples will be collected to determine the extent of contamination in the area. Suggested sample locations are denoted in Figure 6. (Note: The grid in Figure 6 is tied to reference point A, which is 200 feet east of the eastern edge of the grid shown.) Sample locations were generated by picking critical sectors to be sampled and randomizing the placement of sampling points within each sector. Sample depths are presented in Table 6 ("S" denotes surface samples). Sample locations should be modified if discoloration, erosion, or other suggestive signs indicate a more likely area of contamination within each sector. Modifications should be duly noted on copies of Figure 6 and Table 6.

FIGURE 6

LOW LYING AREA ADJOINING SOUTH POND*



* GRID BASED ON REFERENCE POINT A
(See Figure 2)

TABLE 6

SAMPLING LOCATIONS FOR LOW AREA WEST OF SOUTH POND

Sample Number	Sector	Distance South of Ref. Pt. A (ft)	Distance East of Ref. Pt. A (ft)	Depth (ft)
619	D11W	155	518	S[a]
620	D10W	175	462	S
621	D9W	158	411	S
622	D8W	180	368	1.5
623	D7W	178	328	S
624	E11W	244	516	S
625	E10W	237	496	S
626	E9W	248	441	S
627	E8W	223	362	S
628	E7W	204	338	1.5
629	F10W	296	453	S
630	F9W	271	417	1.5

[a]This number represent + or - the number of feet east or west, respectively, of the center line of the swale

[b]Surface samples must be collected within the top 0.5 feet of material

Sampling of the north property line of TRW should be collected as close to the line as feasible given the constraints of the local topology. Beginning at the northeast corner fence post, 20 samples will be collected at random locations proceeding east along the 1,100-foot northern property line. Sample locations are presented in Table 7. The locations are also depicted in Figure 7. All of the twenty samples to be collected are surface samples. Samples in this sequence should not be collected from stream beds, concrete slabs, or other surfaces. Sampling points should be adjusted to avoid such obstacles. Actual locations should be depicted on a copy of Table 7 and a suitable map.

Priority 3

The objective of Priority 3 sampling is to delineate the extent of PCB contamination as a function of depth in the swale.

The Swale (total of 62 samples)

Numerous samples have already been obtained in the swale showing contamination in an irregular pattern with localized hot spots dispersed between areas of relatively little contamination. Two potential migration pathways--horizontal transport of contaminated sediment and vertical migration of PCB due to percolation--are responsible for the current distribution of PCB in the swale.

The swale has been divided into three sections for convenience. These sections are depicted in Figure 8. Section A is 500 feet in length and runs adjacent to the east pad of

TABLE 7*

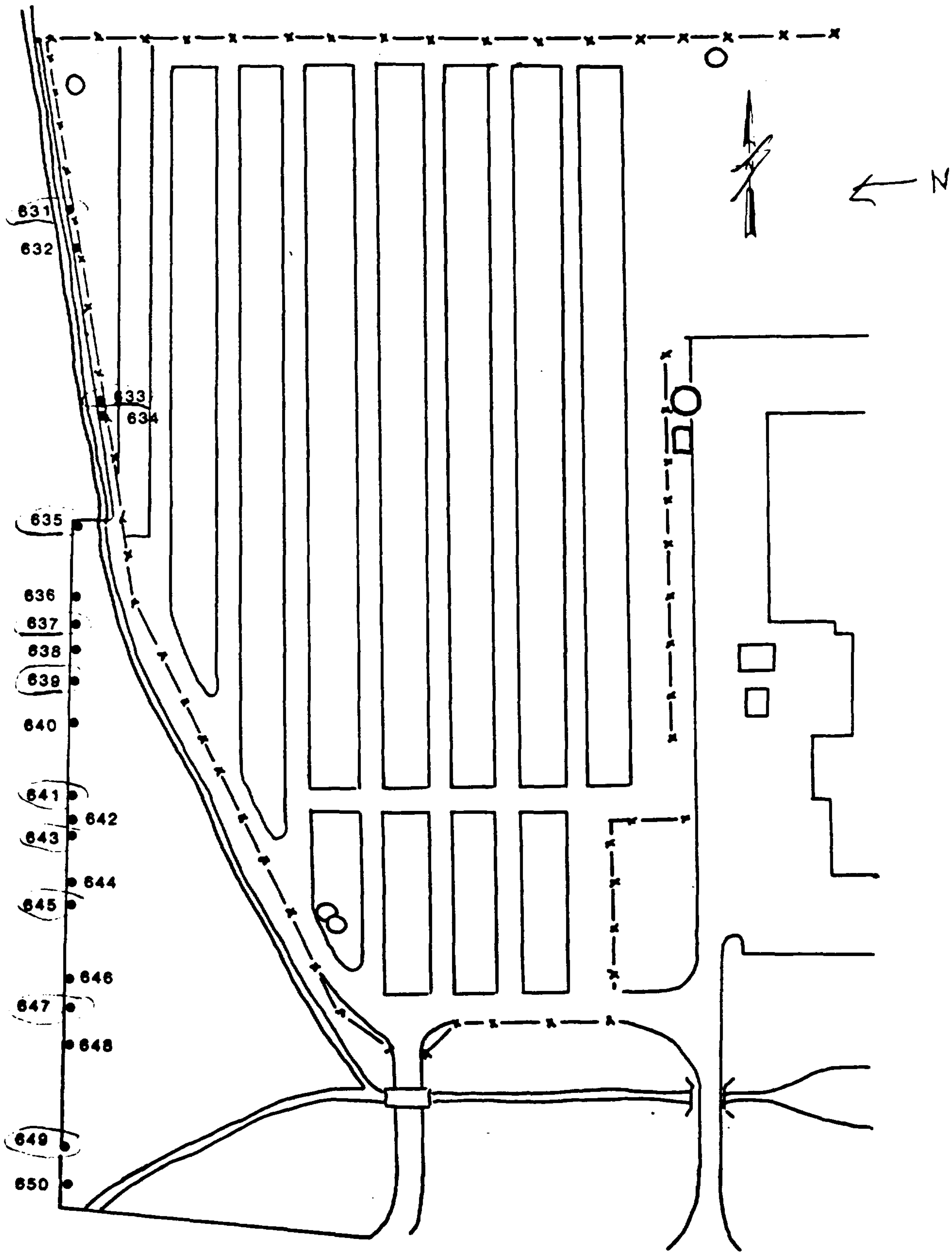
SAMPLE LOCATIONS ALONG
NORTH PROPERTY LINE OF TRW

Sample Number	Distance from Northeast Corner (feet)
631	154
632	187
633	330
634	344
635	473
636	550
637	572
638	594
639	627
640	671
641	726
642	748
643	770
644	803
645	825
646	891
647	913
648	946
649	1,045
650	1,078

*Only odd numbered samples are to be collected.

FIGURE 7

SAMPLING OF NORTH PROPERTY LINE



the plant. The corner section is approximately 400 feet long and consists of the part of the swale which bends around the southeast corner of the plant. (The highest level of contamination is found in this area.) Section B runs 540 feet from the corner section to the stream that is fed by west lake. Contamination in this area is most likely due to surface sediment migration from the corner section. Sampling to be performed in each setion of the swale is described below.

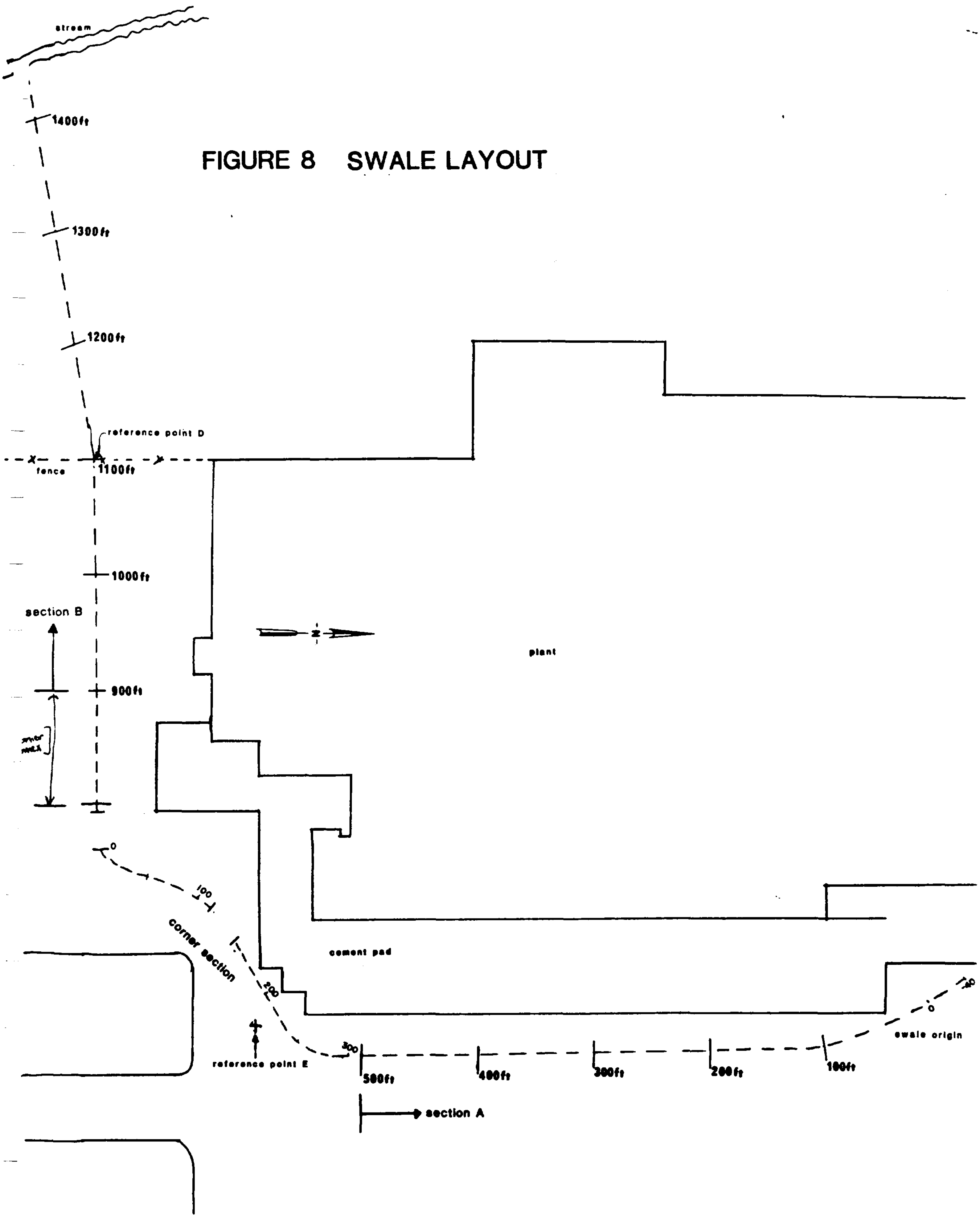
1. Section A

Section A runs north-south adjacent to the cement pad on the east side of the plant. Previous samples collected in Section A of the swale are sufficient to delineate the distribution of contamination in this area. Thus, no additional samples will be collected from Section A at this time.

2. Section B

Section B is the narrow portion of the swale runing east-west along the south side of the plant. Section B is 540 feet in length beginning at the point indicated in Figure 8 and empties into the stream 1440 feet from the swale's origin. To facilitate the location of sampling points, reference point D is defined in the center of the swale at the point where the swale crosses under the fence at the position indicated in Figure 8. This section of the swale is sampled according to the following scheme:

FIGURE 8 SWALE LAYOUT



Depth (ft)	Frequency	Number of Samples
1-5 (randomize)	1/20 feet	27
6-10 (randomize)	1/50 feet	11
		38

Depths and widths for sampling locations were chosen using the following scheme and assuming that the distribution of contamination in the swale approximates a wedge centered in the swale. A vertical profile of the swale was divided into several sampling sectors approximating a wedge shape. The sectors are indicated in Figure 9. Depths were then chosen at random but weighted to reflect the proper frequencies given above. Widths were also generated at random and scaled to the dimensions of each sector at the appropriate depth. Exact locations and depths are listed as a function of distance from the swale's origin in Table 8.

3. The Corner Section

The highest levels of PCB contamination have been recorded in the corner section of the swale, which bends around the southeast corner of the plant. There is significant contamination in this area even at depths of 10 feet. To delineate the extent of contamination as a function of depth, the corner section of the swale will be sampled according to the following scheme:

Depth (ft)	Frequency	Number of Samples
6-10 (randomize)	1/33 feet	12
11-15 (randomize)	1/33 feet	12
		24

Sample locations were generated at random on a 400-foot by 100-foot grid oriented diagonally with respect to the plant

TABLE 8

SAMPLING LOCATIONS FOR SECTION B OF THE SWALE

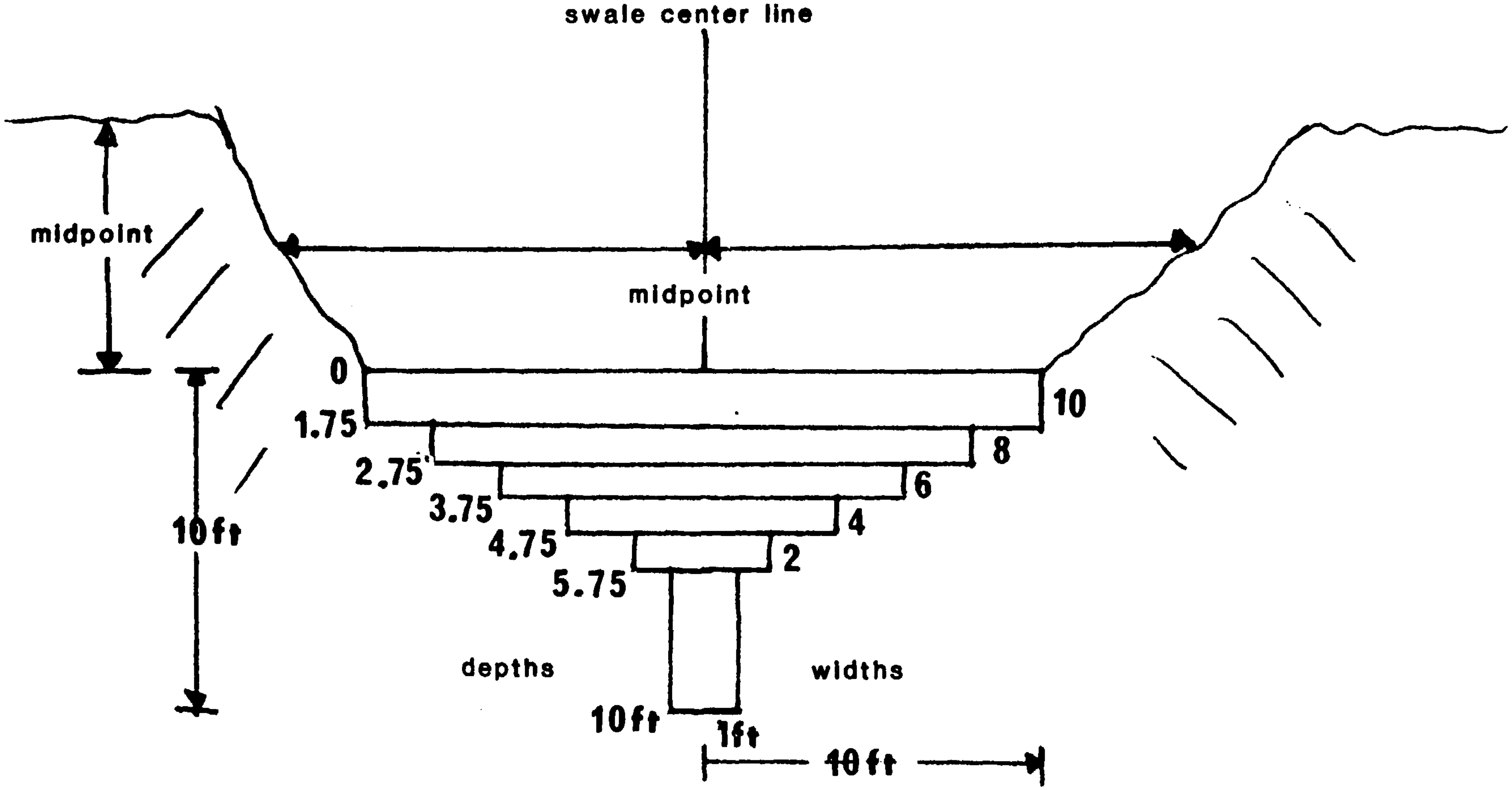
Sample Number	Distance Down Swale (ft)[a]	Depth (ft)	Width[b] (ft)
651	907	1.5	+2.0
652	914.5	6.0	0
653	932.0	2.5	+0.5
654	932.0	9.0	0
655	964.5	2.5	-7.0
656	986.0	1.0	-3.5
657	996.5	1.0	+5.0
658	997.0	5.0	0
659	1001.5	5.5	0
660	1016.0	4.0	+1.5
661	1032.0	1.0	+5.5
662	1032.5	4.5	+3.5
663	1038.0	4.0	-3.5
664	1040.0	1.0	-2.5
665	1058.0	5.5	0
666	1081.0	2.5	+6.5
667	1090.0	9.0	0
668	1093.0	2.0	-8.0
669	1136.0	2.5	-7.5
670	1185.5	6.0	0
671	1195.5	5.5	+0.5
672	1199.0	2.0	-7.5
673	1211.0	10.0	0
674	1259.0	6.0	0
675	1260.0	1.0	+9.4
676	1276.5	5.0	+1.0
677	1281.0	6.0	0
678	1291.5	4.0	0
679	1331.0	7.0	0
680	1341.0	4.0	-2.0
681	1350.5	8.0	0
682	1378.5	1.0	+6.0
683	1388.5	9.0	0
684	1398.5	10.0	0
685	1398.5	4.0	+3.5
686	1401.5	1.0	0
687	1410.5	1.0	-8.4
688	1425.0	1.5	-6.0

(See notes on following page)

[a]Distances presented are referenced to the swale's origin. To facilitate sample location in this section of the swale, reference point D is located where the fence crosses the swale 1100 feet from the swale's origin. Thus, sample points may be determined relative to reference point D by subtracting 1100 from the numbers listed in the column headed "Distance Down Swale." (Following subtraction, negative numbers represent distances east of the fence and positive numbers are west of the fence.)

[b]Distances are recorded as + or - the number of feet north or south, respectively, of the center line of the swale.

FIGURE 9
SECTION B PROFILE



and covering the entire corner section of the swale. Locations for the shallower samples were selected with equal probability over the length and width of the grid. Sites for the deeper samples were selected assuming deep contamination was twice as probable over the 50-foot width of the grid closer to the plant. Chosen sample points located on portions of the grid not suitable for sampling (i.e., parts of the plant or lagoon) were rotated in a systematic manner until a suitable location was obtained.

Sampling locations generated in the manner outlined above were translated onto a second grid to facilitate sample collection. This second grid is centered on the valve stem located in the corner of the swale which has been designated reference point E. Sample locations are denoted in Figure 10. The depths of each sample and distances of each location from reference point E are presented in Table 9.

<u>Priority 4</u>

The objective of priority 4 sampling is to provide a complete picture of the extent of contamination at the Minerva site. Additional sampling will be performed in several areas for this purpose.

A. <u>The South Pond</u> (Total of 32 samples)

The level of contamination in the sediment of south pond will be determined as a function of depth. Eight core samples will be obtained from the locations indicated in Figure 11. Exact locations are presented in Table 10. Each core sample

TABLE 9

LOCATIONS FOR SAMPLING THE CORNER SECTION OF THE SWALE

Sample Number	Sector	Distance North-South of Ref. Pt. E[a] (ft)	Distance West-East of Ref. Pt. E[b] (ft)	Depth (ft)
689	1N1E	+49	-49	9.5
690	2N1E	+52	-46	13.0
691	1N1E	+2	-37	6.5
692	2N1W	+60	+1	12.0
693	1N1W	+43	+6	11.5
694	1S1E	-26	-11	7.5
695	2N1E	+94	-21	13.5
696	1N1W	+20	+37	14.5
697	1N1W	+18	+49	11.0
698	1S1W	-8	+42	9.5
699	1S1W	-4	+46	10.0
700	1S2W	-6	+55	13.5
701	1N2W	+3	+63	9.0
702	2N1W	+83	+6	15.0
703	2N1E	+71	-10	11.5
704	2S2W	-58	+85	7.5
705	2S3W	-95	+132	7.5
706	2S3W	-77	+140	12.5
707	2S4W	-77	+155	9.0
708	3S3W	-110	+145	12.0
709	2S4W	-81	+169	6.0
710	3S5W	-143	+217	15.0
711	2S5W	-97	+248	9.5
712	3S6W	-105	+269	6.5

[a]Distances are + or - the distance north or south, respectively, of reference point E.

[b]Distances are + or - the distance west or east, respectively, of reference point E.

FIGURE 10
SWALE CORNER SECTION

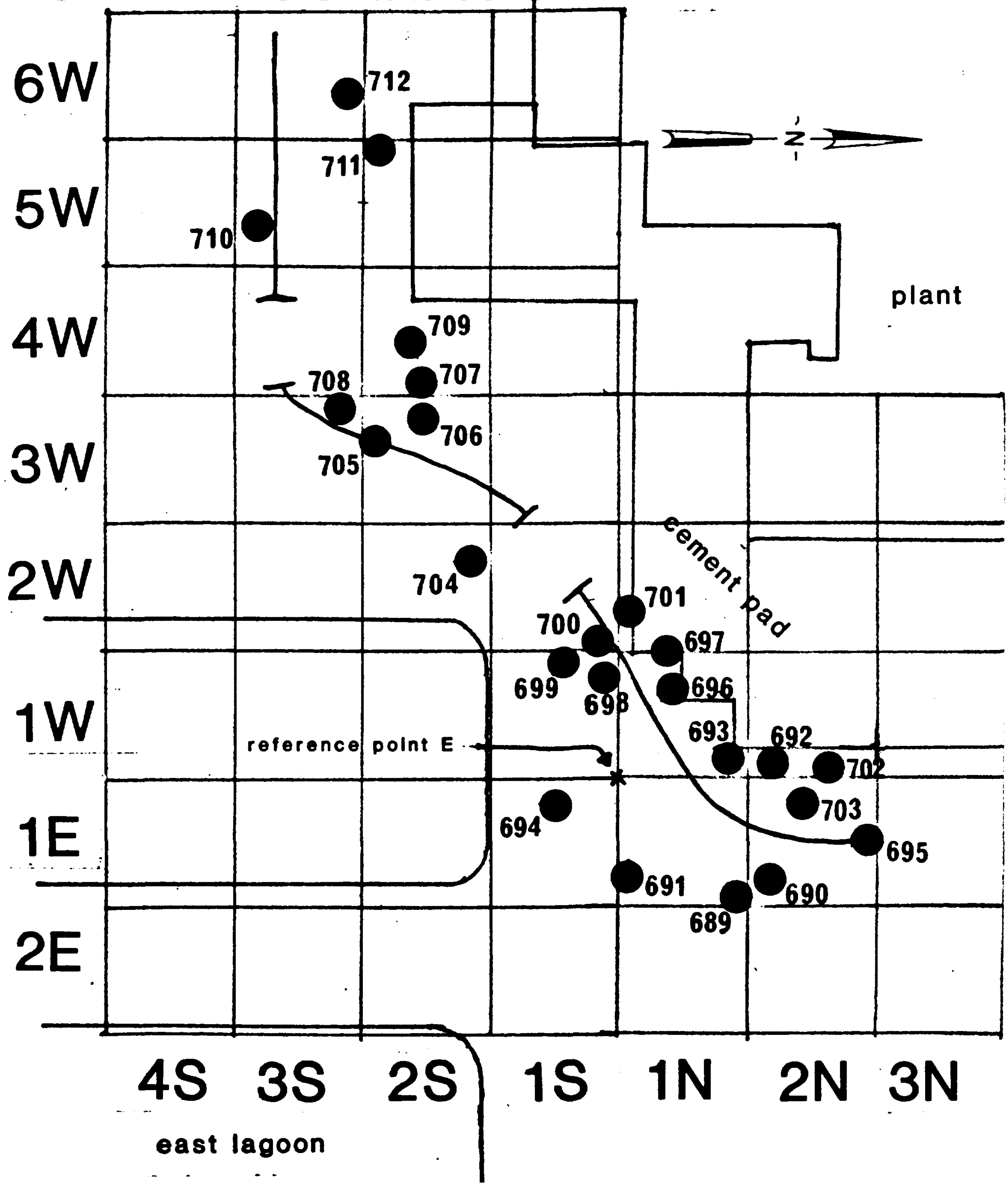


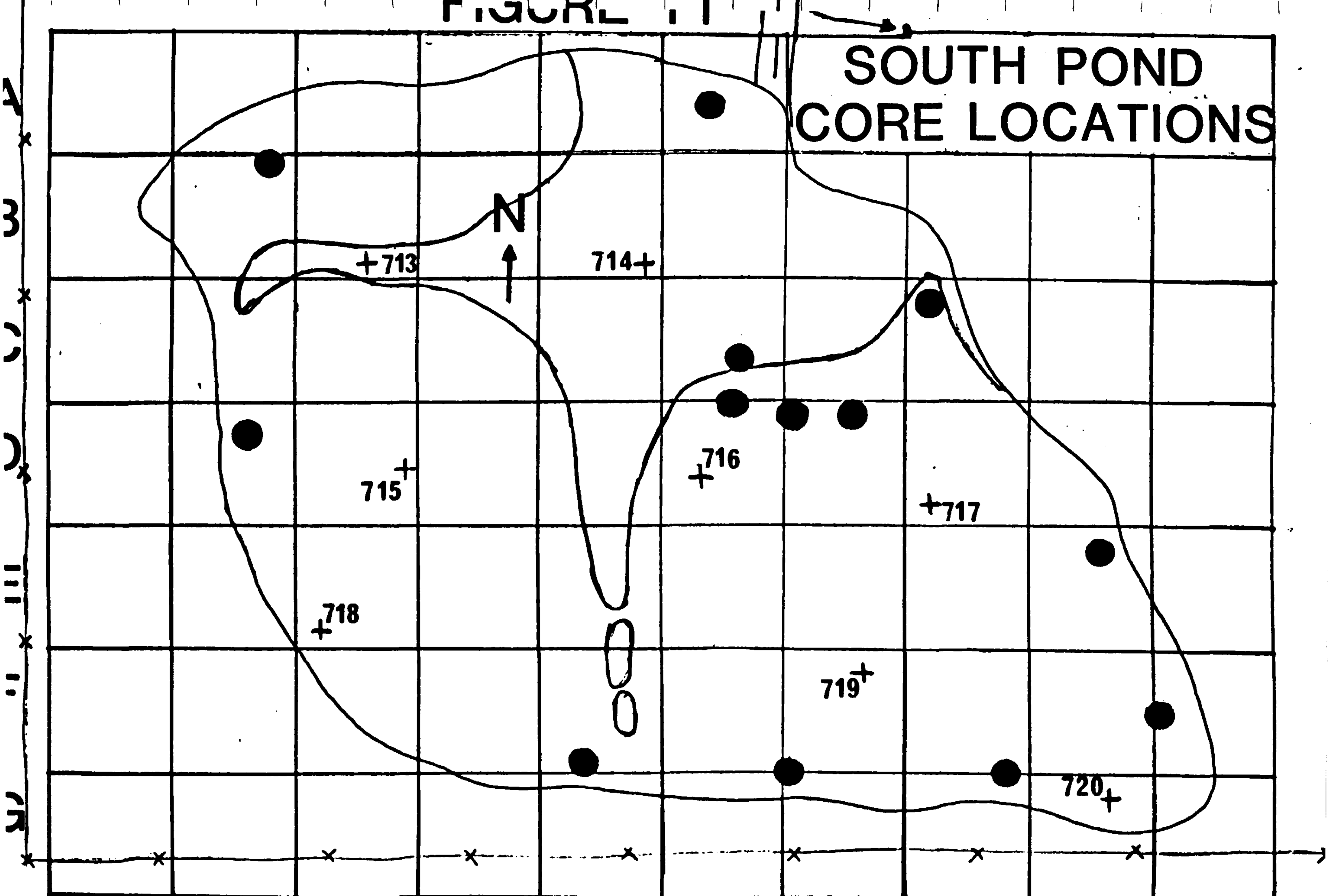
TABLE 10

LOCATIONS FOR CORE SAMPLES IN SOUTH POND

Sample Number	Sector	Distance South of Ref. Pt. A (feet)	Distance West-East[a] of Ref. Pt. A (feet)	Depth (feet)
713a	B5W	93	+221	1.0
b				1.5
c				2.5
d				4.0
714a	B3W	96	+108	1.0
b				1.5
c				2.5
d				4.0
715a	D5W	178	+205	1.0
b				1.5
c				2.5
d				4.0
716a	D2W	182	+85	1.0
b				1.5
c				2.5
d				4.0
717a	D1E	190	-13	1.0
b				1.5
c				2.5
d				4.0
718a	E5W	241	+238	1.0
b				1.5
c				2.5
d				4.0
719a	F1W	263	+18	1.0
b				1.5
c				2.5
d				4.0
720a	G2E	315	-79	1.0
b				1.5
c				2.5
d				4.0

[a]This number represents + or - feet west or east, respectively, of reference point A.

FIGURE 11



existing sampling locations

will be analyzed at four depths: 1.0 feet, 1.5 feet, 2.5 feet, and 4 feet.

The following procedure should be used for obtaining core samples from the pond sediment to facilitate sealing cores after the samples are withdrawn.[1] A section of schedule 40 or schedule 60 PVC or polyethylene drainage pipe, which is beveled at one end, will be used as a barrier to provide a dry area for work. To sample, the pipe is first driven into the sediment surrounding a sampling location. Standing water within the pipe is withdrawn using a parastaltic pump. Sample cores can then be collected and the cores backfilled and sealed with bentonite in the manner perscribed earlier in this sampling plan. When the sealing operation is completed, the pipe may be withdrawn for reuse.

B. <u>The Rubble Pile</u> (Total of 11 samples)

The extent of PCB migration caused by runoff from the rubble pile will be examined by collecting surface samples along the east fence of the TRW property. Samples should be collected at 50 foot intervals beginning at the southeast corner of the fence and proceeding north along the east fence a distance of 550 feet. If these distances are correct, the last of 11 samples will be collected in the vinicity of old sample number 145. Samples should be numbered consecutively beginning with 721.

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[1]This procedure can also be used to obtain core samples from submerged locations in other areas on the site such as the wax ditch and west lake.

C. The Fry Property (Total of 46 samples)

Forty-six samples will be collected from the Fry property to determine the extent of contamination. Sample locations are denoted on a grid map in Figure 12. (The southeast corner of the fence has been designated reference point F and serves as the origin of the grid in Figure 12.) Sample locations were generated by picking critical sectors and placing a sampling point at random within each sector. However, sectors that have been sampled previously will not be resampled at this time. Samples will be collected from the surface, at one foot, or at two feet. Depths were chosen at random and weighted so that surface samples, one foot samples, and two feet samples have a frequency of 4:2:1, respectively. Sample depths and locations relative to reference point F are presented in Table 11.

TABLE 11

GRID SAMPLE LOCATION FOR FRY PROPERTY

Sample Number	Sector	Distance South of Ref. Pt. F (feet)	Distance West-East[a] of Ref. Pt. F (feet)	Depth (feet)
732	A15W	32	+716	S
733	A13W	26	+634	2.0
734	A11W	43	+534	1.0
735	A6W	16	+297	S
736	A5W	14	+242	S
737	A3W	8	+148	S
738	A1E	38	-40	1.0
739	A3E	5	-123	S
740	B15W	73	+746	1.0
741	B14W	71	+690	1.0
742	B10W	90	+463	1.0
743	B6W	70	+253	1.0
744	B5W	74	+217	S
745	B3W	96	+117	S
746	B2W	98	+95	S
747	B1W	94	+1	S
748	B1E	93	-11	S
749	B2E	56	-92	1.0
750	B3E	59	-110	S
751	B4E	60	-173	S
752	C15W	118	+743	S
753	C14W	147	+660	2.0
754	C11W	147	+503	S
755	C5W	109	+202	S
756	C4W	134	+170	S
757	C3W	103	+136	S
758	D15W	175	+741	S
759	D14W	161	+655	1.0
760	D13W	167	+644	2.0
761	D12W	182	+568	1.0
762	D8W	156	+351	S
763	D6W	186	+269	S
764	D5W	179	+213	S
765	D4W	196	+193	1.0
766	D3W	185	+133	S
767	E15W	225	+721	S
768	E14W	225	+664	1.0
769	E13W	212	+648	1.0
770	E12W	218	+567	S
771	E11W	234	+531	S

TABLE 11 (Cont'd.)

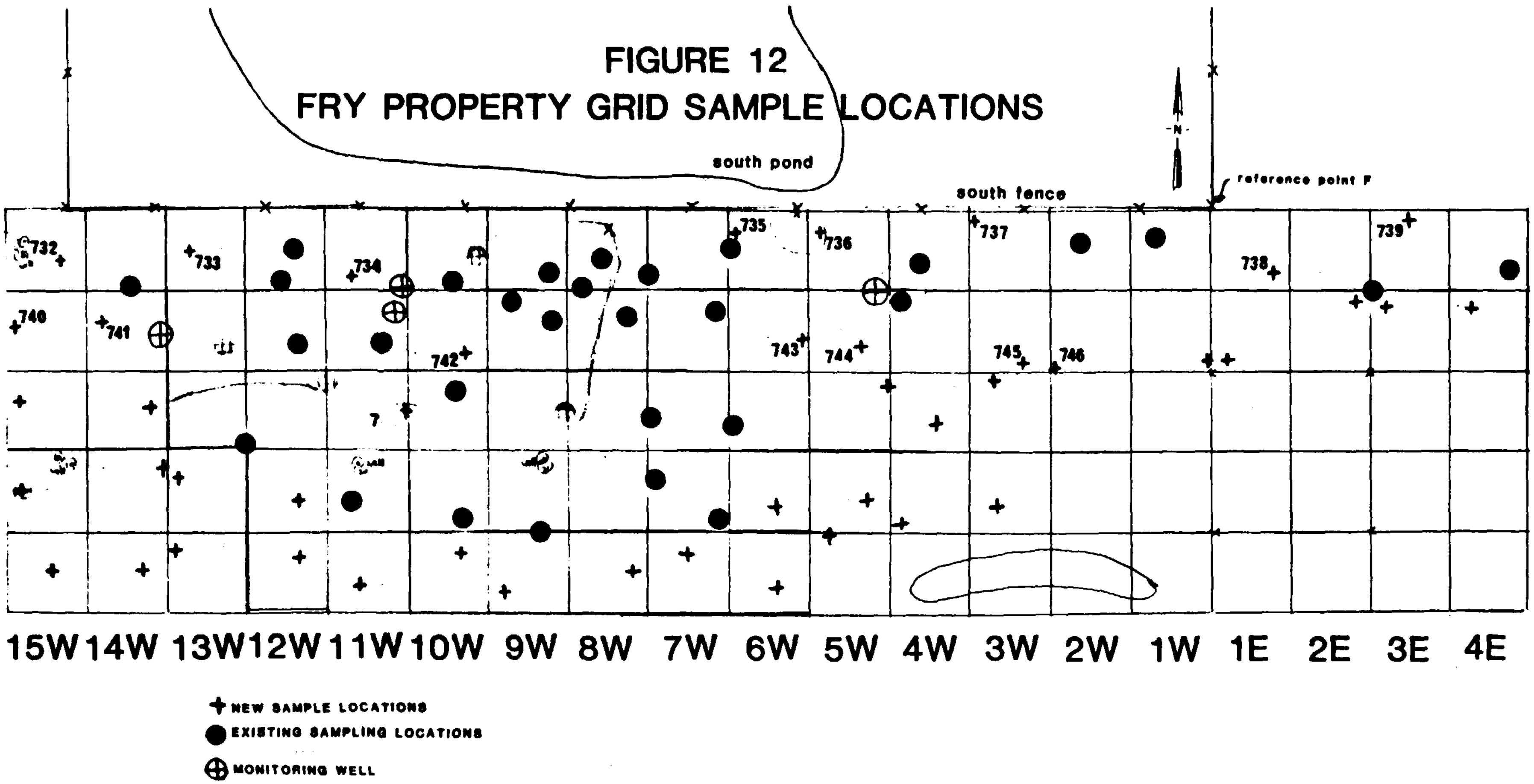
GRID SAMPLE LOCATION FOR FRY PROPERTY

Sample Number	Sector	Distance South of Ref. Pt. F (feet)	Distance West-East[a] of Ref. Pt. F (feet)	Depth (feet)
772	E10W	215	+467	S
773	E9W	238	+439	S
774	E8W	227	+360	S
775	E7W	213	+326	1.0
776	E6W	236	+268	2.0
777	E5W	202	+237	1.0

[a]This number represents + or - feet west or east, respectively, of reference point F.

[b]Surface samples must be collected within the top 0.5 ft. of material.

FIGURE 12
FRY PROPERTY GRID SAMPLE LOCATIONS



Supplemental Sampling Program

This supplemental sampling program covers the remaining sample data required to complete analysis of remedial options for the TRW, Minerva site. The sampling program outlined in this report will be followed by a discussion with TRW of sample collection requirements and overall goals so that additions and modifications may be finalized.

The Rubble Pile (total of 50 samples)

Knowledge of the distribution of contamination due to migration from the rubble pile is required to determine the quantity of soil to be considered for remedial action. To obtain a vertical profile of contamination, samples will be collected at depths of 1.5, 3, and 6 feet from fifteen cores obtained from the rubble pile and surrounding areas. Five of the cores will also be sampled at 9 feet. Core locations were determined from a grid map of the rubble pile in the following manner. To assure that all of the important strata in the rubble pile would be sampled, critical sectors representing each strata are identified on the grid map. Sampling points are located at random within each critical sector. Locations are depicted in Figure 13. Depths and distances from fixed reference points are also presented for these samples on Table 12.

TABLE 12

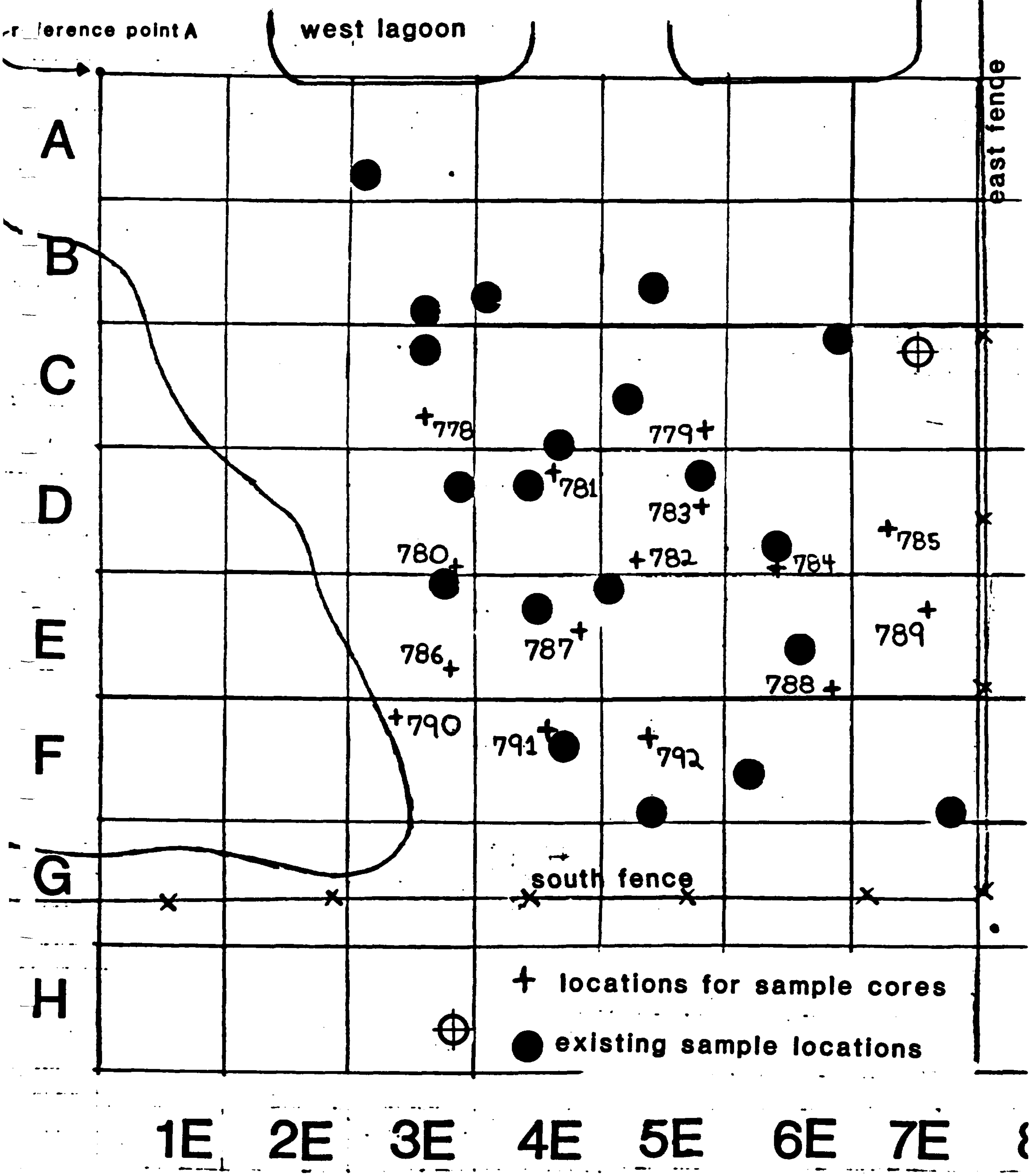
RUBBLE PILE CORE LOCATIONS

Sample Number	Sector	Distance South of Ref. Pt. A	Distance East of Ref. Pt. A	Depth
		(feet)	(feet)	(feet)
778a	C3E	136	130	1.5
b				3
c				6
779a	C5E	141	243	1.5
b				3
c				6
780a	D3E	198	141	1.5
b				3
c				6
d				9
781a	D4E	157	182	1.5
b				3
c				6
782a	D5E	193	218	1.5
b				3
c				6
783a	D5E	172	241	1.5
b				3
c				6
d				9
784a	D6E	198	273	1.5
b				3
c				6
785a	D7E	176	314	1.5
b				3
c				6
786a	E3E	238	138	1.5
b				3
c				6
d				9

TABLE 12 (Continued)

Sample Number	Sector	Distance South of Ref. Pt. A	Distance East of Ref. Pt. A	Depth
		(feet)	(feet)	(feet)
787a	E4E	224	191	1.5
b				3
c				6
788a	E6E	248	293	1.5
b				3
c				6
789a	E7E	214	328	1.5
b				3
c				6
d				9
790a	F3E	261	119	1.5
b				3
c				6
791a	F4E	268	182	1.5
b				3
c				6
792a	F5E	273	218	1.5
b				3
c				6
d				9

FIGURE 13
RUBBLE PILE CORES



SAMPLING SUPPLEMENT NO. 2

The principal purpose of this supplement is to complete determination of PCB contamination levels at the borders surrounding the Minerva site. Samples will be collected for this purpose from the eastern parking lot boundary and the front yard by west lake. In addition, 10 samples will be collected as part of this program for two ancillary purposes: (1) to check the integrity of the PCB storage shed and (2) to monitor runoff from the parking lot.

<u>Borders</u> (total of 16 samples)

Eight samples will be collected from the eastern parking lot boundary as close to the fence as possible. Starting at the northeast fence corner, where the first sample will be obtained, surface samples should be collected every 100 feet extending to the vicinity of well No. 17. A total distance of 700 feet will be covered in this manner (see Figure 14). Samples should be numbered consecutively beginning with 793. In a similar manner, eight samples will be collected from the front yard along the western border of the property. Starting at the north property line (where samples have already been obtained) a sample should be collected every 200 feet in a line paralleling the road on the western boundary of the property as depicted in figure 14. Samples should be collected 50 feet in from the road.

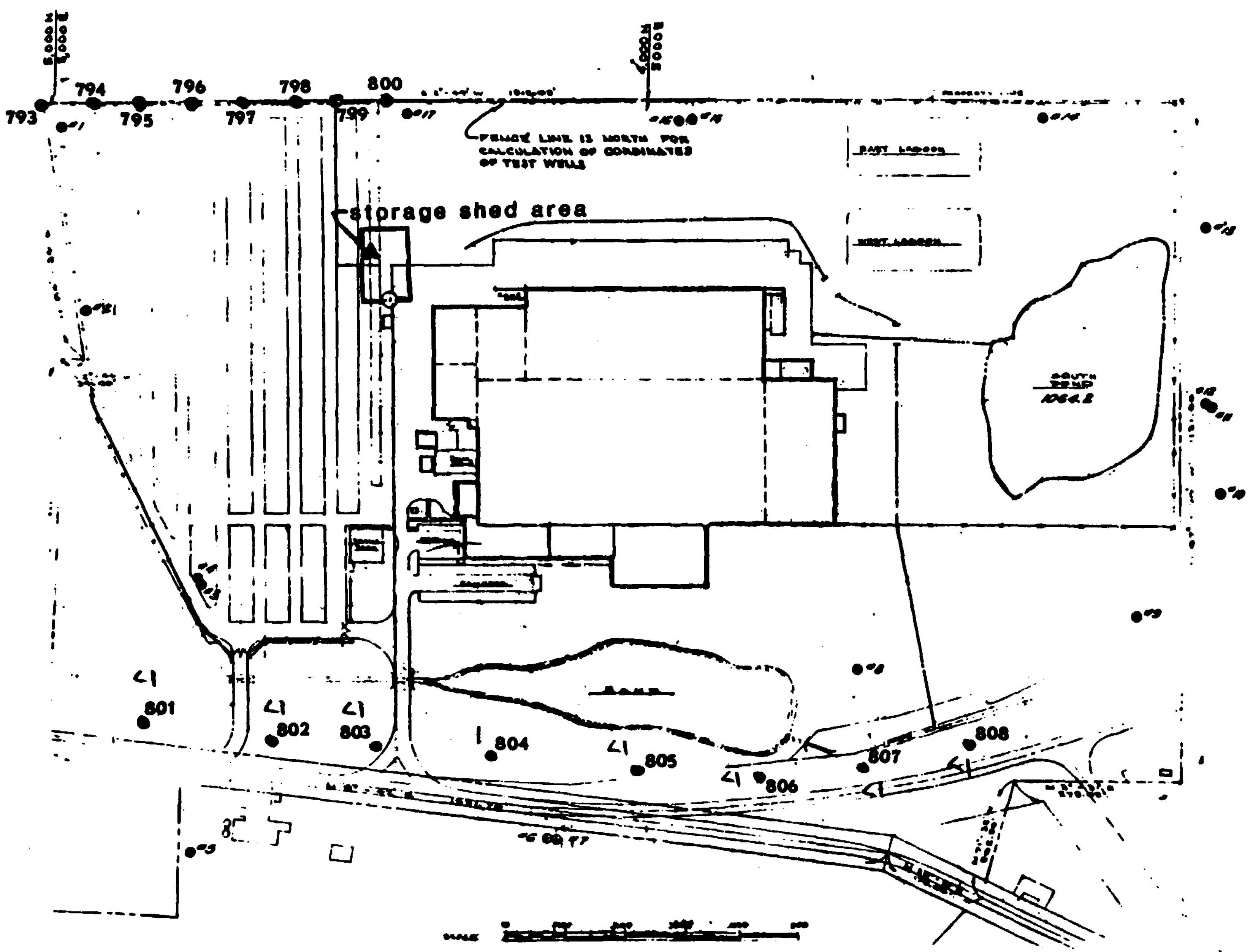
Storage Shed (total of 5 samples)

Five surface samples should be collected in the vicinity of the storage shed to determine the level of surface contamination in the area. Samples should be chosen on site within the box on Figure 14 labeled "storage shed area."

Parking Lot Runoff (total of 5 samples)

The path of runoff from the parking lot will be determined either by direct observation or from physical evidence. Five samples will be collected at appropriate low areas, where particles are likely to collect, within the pathways determined.

FIGURE 14 SUPPLEMENT NO. 2 SAMPLING



SAMPLING PLAN FOR DETERMINING THE OCCURRENCE AND POTENTIAL IMPACT OF VOLATILE ORGANIC COMPOUNDS AT THE TRW MINERVA SITE

Draft Plan

Prepared for:

TRW Inc.
Minerva, Ohio

Prepared by:

Clement Associates
1515 Wilson Boulevard
Arlington, VA 22209

July 11, 1984

BACKGROUND

On December 20, 1983, TRW presented a detailed remedial action plan to representatives of the Ohio EPA and USEPA designed to address potential health and environmental problems associated with residual PCB contamination detected in soils and sediments at the TRW plant in Minerva, Ohio. Though studies indicate that residual PCBs at the TRW plant present a negligible risk to public health and the environment, proposed remediation is intended to reduce such risks uniformly to insignificant levels. This plan is currently undergoing review by both state and federal agencies.

On March 27, 1984, the Ohio EPA raised a concern that other organic compounds might be present at the Minerva site and requested additional information concerning an early study of such compounds. A gross scan to detect other organic compounds at concentrations potentially sufficient to impact transport of PCBs at the site had already been conducted with negative results. However, this early study did not eliminate the possibility that such compounds might be present at lower concentrations. Accordingly, the Ohio EPA on May 16, 1984, formally requested that complete volatile organic scans be performed on groundwater samples collected from monitoring wells 2, 10, 12, 13, 14, and 19 at the Minerva site.

Results of the analyses, summarized in Table 1, indicate that samples from wells 10, 14, and 19 exhibited detectable

TABLE 1

CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUNDWATER SAMPLES FROM WELLS AT THE TRW MINERVA SITE

(CONCENTRATIONS IN PPB)

Wells	1[a]	2[b]	8[a]	9[a]	10[a,b]	11[a]	12[a,b]	13[b]	14[b]	18[a]	19[a,b]	20[a]	21[a]
1,1,1-Trichloroethane				30	11					Trace[c]	Trace[c]		
1,1-Dichloroethane				22	200(47)	26				108	1,500(12)		Trace[c]
1,2-Dichloroethane					Trace[c]					Trace[c]	10	Trace[c]	Trace[c]
Chloroethane										110			
Trichloroethylene					120(39)	12				Trace[c]	1,300(13)		Trace[c]
1,1-Dichloroethylene					Trace[c]						25		Trace[c]
Trans-1,2-dichloroethylene					320(120)	45	10		(30)	11	910(32)	15	45
Vinyl chloride											91		
Acetone						59							

[a]Sampled as part of the preliminary investigation. Only positive results are listed in this table. Results were reported on June 26, 1984.

[b]Sampled in response to a request by the Ohio EPA. Positive results are listed in parentheses. Results were reported on June 1, 1984.

[c]Detected at concentrations below the stated 10 ppb detection limit.

quantities of 1-3 of the 30 compounds normally evaluated in a complete volatile organic scan. All other results were negative. Compounds detected in the three wells at concentrations exceeding the 10 parts per billion (ppb) detection limit were trichloroethylene in wells 10 and 19, 1,1-dichloroethane in wells 10 and 19, and t-1,2-dichloroethylene in wells 10, 14, and 19. Concentrations ranged up to 120 ppb in well 10 but remained near the detection limit in wells 14 and 19.

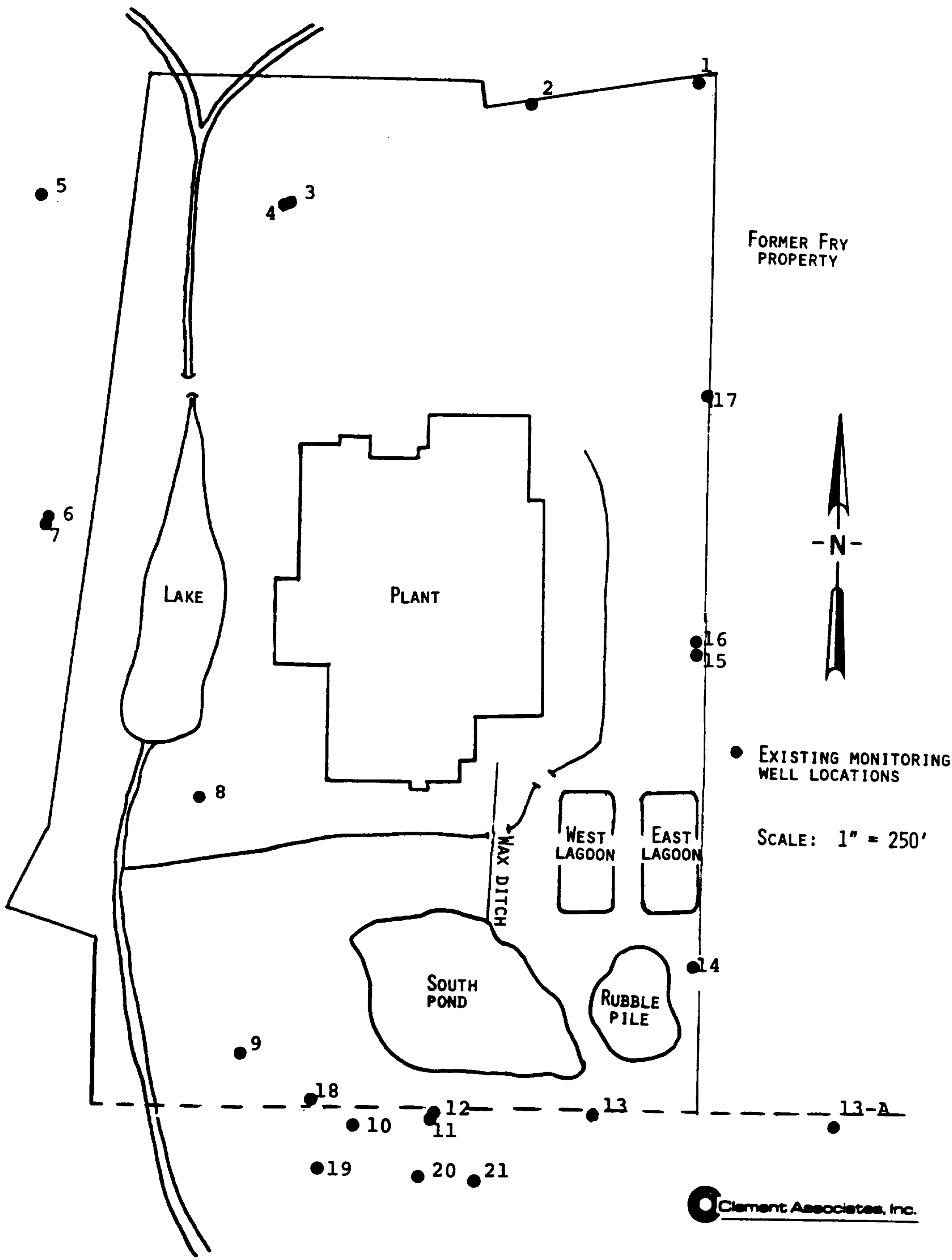
Motivated by the detection of three new chlorinated organic compounds in groundwater at the Minerva site, TRW retained Clement Associates to evaluate the significance of these results. A preliminary study was initiated to provide an indication of the scope of the problem. The purpose of the preliminary study was to confirm the results of the requested groundwater analyses, provide an indication of the potential sources of such materials at the site, and collect information on the behavior of these compounds in the environment. Thus, volatile organic scans were performed on fresh groundwater samples from monitoring wells at the site, a small number of samples were collected from known sources of PCBs at the site (including the swale, the wax ditch, and South Pond) and analyzed for volatile organics, and information was developed concerning the historical use of such materials at the facility.

Results of the preliminary study confirm that groundwater samples taken from several downgradient wells at the site exhibit detectable concentrations of a number of volatile organic compounds. The compounds detected include 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, and trans-1,2-dichloroethylene. Traces (concentrations below the reported limit of detection) of acetone, chloroethane, and vinyl chloride were also detected. Results of these groundwater analyses are also summarized in Table 1. Because of the scatter in the data reported at this time, however, the actual concentrations of these compounds and the significance of their relative distributions cannot be determined.

Information developed on the past use of volatile organics at the site and results of soil and sediment analyses from the preliminary study indicate that the wax ditch and South Pond are potentially the principal sources of these materials on the TRW property. Information gleaned from inventory records and interviews with senior plant personnel suggest that approximately 10,000 gallons per year of TCE were used for degreasing and other purposes. TCA was substituted for TCE in all plant applications beginning in 1972. Since 1972, TCA use roughly paralleled that of the TCE it replaced. Although other volatile organics observed in groundwater at the site were apparently never used at the plant, many of the compounds detected represent possible degradation products of TCE and TCA in the environment. These materials, therefore, would be likely to originate from the same sources as TCE and TCA.

FIGURE 1

SITE PLAN OF TRW, MINERVA



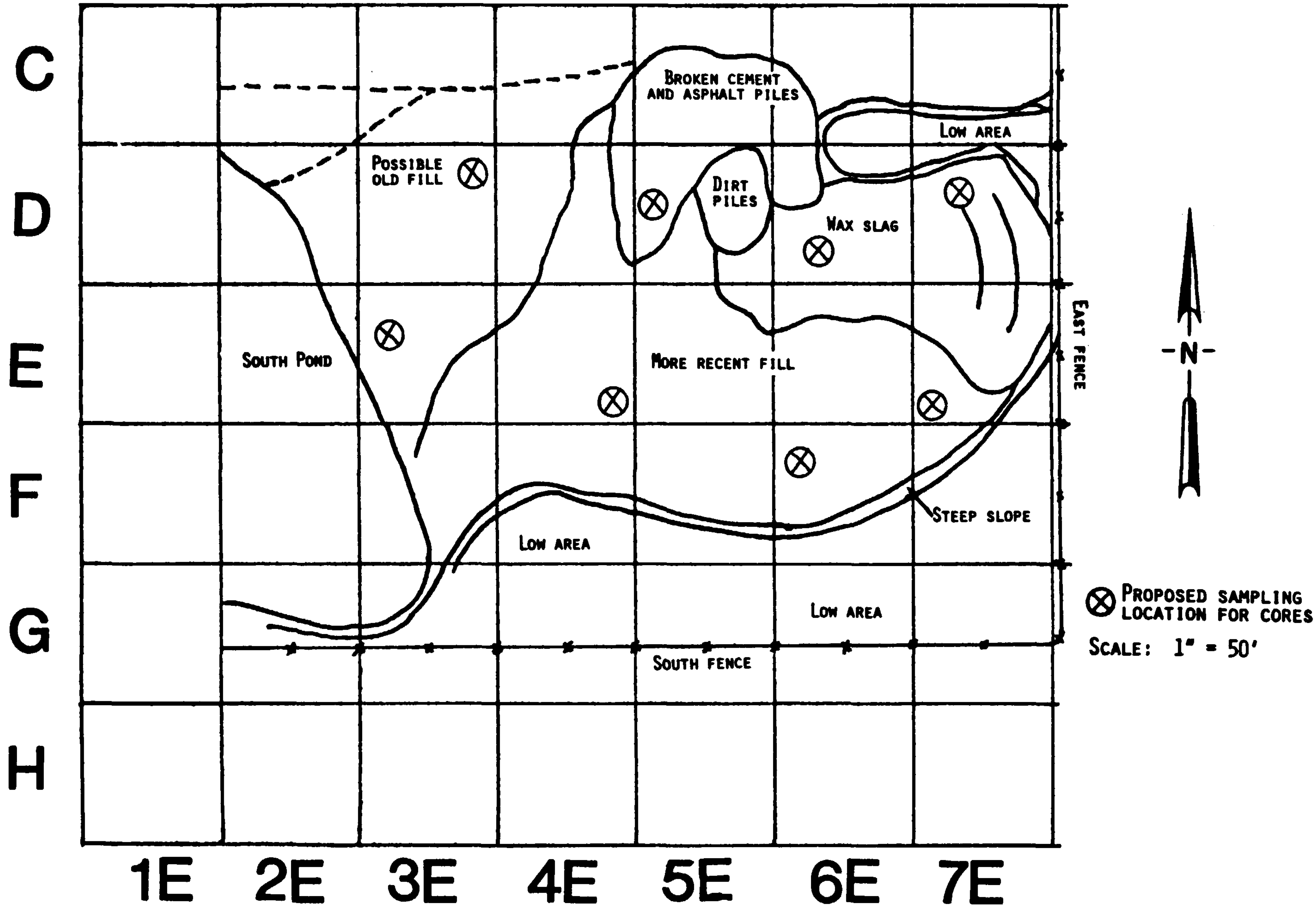
WORK PLAN

The TRW Minerva Site is depicted in Figure 1. Previous sampling data indicate that portions of the site are contaminated with PCBs from a protracted spill. Recent groundwater analysis suggests that volatile organics may also be present on site. The purpose of the proposed investigation is to determine the relative concentrations and the distribution of volatile organics in the groundwater at the Minerva site, to confirm the hypothesis that the wax ditch and South Pond are the principal potential sources of these compounds, to evaluate the potential impact of volatile organics at the Minerva site both individually and with respect to PCB concentrations also known to be present, and to provide information to develop an appropriate remedial response to address potential problems posed by the presence of volatile organics.

Since the behavior of volatile organic compounds in the environment is a function of their physicochemical properties, these are summarized in Table 2 for volatile organics detected in groundwater at the Minerva site. Properties of Aroclor 1254, the principal PCB mixture present at the site, are also provided for comparison. In contrast to PCBs, the other organics listed in Table 2 are volatile and exhibit substantial vapor pressures at room temperature. All of the compounds listed are also fairly soluble in water compared to PCBs. The logs of the

FIGURE 4

PROPOSED LOCATIONS FOR CORE SAMPLES IN THE RUBBLE PILE



Clement Associates, Inc.

Until 1981, when new hazardous waste handling procedures were adopted at the plant, spent degreasers were apparently collected in a tank and deposited in the wax ditch, which runs from the south end of the plant to the South Pond. Based on the known physical properties of these materials, it is likely that a significant fraction of the material dumped in the wax ditch evaporated. Most of the remaining material probably dissolved in the waxy residues also deposited in the ditch during this period. Concentrations of TCE and TCA may also have been introduced into South Pond when waxy residues flowed down the ditch and mixed with pond sediments. The wax ditch and South Pond thus represent the most probable sources of volatile organics at the site.

Results of soil and sediment analyses from the preliminary investigation generally support the hypothesis that the wax ditch and South Pond represent the principal potential sources of volatile organics on the site but are inconclusive because of the limited number of samples collected. None of the six samples collected in the swale, which were taken at 1-foot and 3-foot depths, exhibited any observable concentrations of volatile organic compounds to a detection limit of 0.2 parts per million (ppm). Thus, it is unlikely that the swale is currently a source of volatile organics. In contrast, volatile organics were detected in all three samples of wax ditch residues at concentrations ranging between 0.5 and 800 ppm. In addition, although neither of the two samples of South Pond sediments yielded detectable concentrations of volatile organics, the distribution of waxy residues in pond sediments is known to be irregular so that a larger number of samples may be required to ensure that appropriate deposits are being sampled.

Based on the discovery of concentrations of volatile organics in groundwater at the Minerva site and the results of the preliminary investigation, further study is deemed warranted. A work plan for this study is detailed in the following sections.

TABLE 2

PHYSICAL AND CHEMICAL PROPERTIES OF CHLORINATED ORGANICS FOUND IN GROUNDWATER AT THE TRW MINERVA SITE

Compound	Molecular Weight	Specific Gravity (Water=1)	Melting Point (° C)	Boiling Point (° C)	Vapor Pressure (mmHg at 20° C)	Water Solubility (mg/liter at 20° C)	Log of the Octanol-Water Partition Coefficient[a]	Henry's Law Constant (atm m^3/mole)x10^3	Carbon Adsorption (mg/liter)[b]
1,1,1-Trichloroethane	133.4	1.34	-30.4	74.1	96.0	950	2.17	1.4	3,600
1,1-Dichloroethane	98.96	1.17	-97.0	57.3	180	5,500	1.79	--	5,000
1,2-Dichloroethane	98.98	1.26	-35.4	83.5	61	8,300	1.48	0.04	2,500
Chloroethane	64.52	--	-13.6	12.3	1,000	5,740	1.54	--	15,000
Trichloroethylene	131.4	1.46	-73	87	57.9	1,100	2.29	0.365	430
1,1-Dichloroethylene	96.94	1.21	-122	37	591	5,000	1.48	6.3	1,800
trans-1,2-t-Dichloroethylene	96.94	1.28	-50	47.5	200	6,300	1.48	--	3,000
Vinyl chloride	62.50	--	-160	-13.4	2,660	60	0.60	--	--
Aroclor 1254[c]	326	1.5		365-390	7.7×10^{-5}	0.05	6		

[a] log kow = low $\frac{\text{concentration in octanol phase}}{\text{concentration in water phase}}$

[b] carbon dose (filtrasorb - 300) required to reduce pollutant concentration from co mg/liter to 1 mg/liter at neutral pH

[c] Principal PCB mixture found at the site; its properties are provided for comparison.

octanol/water partition coefficients for the compounds listed suggest that these compounds, unlike PCBs, are not readily adsorbed on inorganic soil particles. Thus, volatile organics are expected to behave differently than PCBs at the Minerva site both because their properties differ and because the method of introduction at the site differs. These factors were considered during the development of this study.

Evaluation of the properties of volatile organics suggests that the two principal transport mechanisms for such compounds suspected to be present at the Minerva site are volatilization and percolation. Residence times for these compounds in surface water and sandy topsoil are short due to volatilization. Thus, a substantial fraction of volatile organics potentially introduced at the site have probably evaporated and dispersed, and these compounds are unlikely to be detected in any materials directly exposed to air. Since they do not readily adsorb on silicate soils, any remaining fraction of material that does not evaporate is likely to percolate vertically until it reaches the water table. These compounds would then likely spread horizontally with groundwater flow because they are relatively soluble in water. Volatile organics are also soluble in other organic matrices, however. Therefore, these compounds would be expected to accumulate in waxy residues such as the sludges present in the wax ditch and sediments in South Pond. Organics adsorbed in waxy residues should be relatively immobile. Thus, the most likely places on the Minerva site where volatile organics might be detected (other than groundwater) are the deeper layers of waxy residues found in the wax ditch and South Pond. Waxy materials are also found in the rubble pile and, if groundwater downgradient of the rubble pile exhibits concentrations of volatile organics, this potential source will have to be considered as well.

Sampling Procedure

Samples will be collected, handled, and analyzed as prescribed under method 8010 of "Test Methods for Evaluating Solid Wastes" (USEPA SW-846, 1982). Procedures for collecting samples, transferring them to storage bottles, and handling the storage bottles are detailed in Section 6.0 of Method 8010. Water samples will be prepared and analyzed in a manner allowing a detection limit of 10 ppb. Soil samples will be prepared and analyzed in a manner allowing a detection limit of 0.2 ppm. Samples must be analyzed within 14 days of collection.

Groundwater samples will be collected for analysis with a bailer. Transfer of groundwater should be performed expeditiously to minimize loss of volatile components. Wells will be evacuated before sampling. The procedure to be used for evacuating groundwater monitoring wells was described in an earlier document, "Groundwater Monitoring Program for the TRW site, Minerva, Ohio" (Clement Associates 1982).

Core soil samples must be backfilled with bentonite after sample withdrawal. Briefly the core is backfilled with bentonite pellets 1 foot at a time. After each foot of bentonite is added, a quantity of water equal to 10% of the clay volume is poured over the added clay to promote swelling. The process is then repeated until the core is filled.

Core samples of submerged sediments on site will be obtained using the following procedure, which will facilitate sealing cores after sample withdrawal. A section of schedule 40 or schedule 60 PVC or polyethylene drainage pipe, beveled at one end, will be used as a barrier to provide a dry area for work. To sample, the pipe is first driven into the sediment surrounding a sampling location. Standing water within the pipe is withdrawn using a peristaltic pump. Sample cores can then be collected and the cores backfilled and sealed with bentonite in the manner perscribed earlier in this sampling plan. When the sealing operation is completed, the pipe may be withdrawn for reuse.

The protocols to be incorporated into the sample handling procedure are presented in the appendix to this report.

Sampling Program

Based on current knowledge of conditions at the site and historical waste handling procedures, the most likely sources of volatile organics on the TRW Minerva property are the wax ditch and South Pond.[1] The sampling program is therefore designed to test this hypothesis and provide information required to evaluate potential remedial alternatives in an efficient and effective manner. Sampling will be conducted in phases so

[1]If contaminated groundwater is detected south of the rubble pile, this area will be considered as well.

that results of earlier analyses can serve as a basis for targeting further sampling. Thus except for Phase 1, the following plan is tentative and subject to modification. It is even likely that the need for sampling outlined in later phases will be obviated by earlier results. Each section therefore includes decision criteria to determine the manner in which the sampling program may be modified based on results of earlier phases.

The first phase of the following plan deals with a groundwater investigation. Later phases involve soil and sediment sampling. Groundwater samples will be obtained from existing monitoring wells at the Minerva site. Core samples of sediment will be collected from South Pond and the wax ditch, and core samples of soil will be collected from the rubble pile. Approximate soil and sediment sampling locations are shown on grid maps derived from a master sampling map of the site that was originally developed to display results of the remedial investigation of PCBs. Results of the analysis will be accompanied by similar grid maps denoting actual sampling locations. These maps can then be compared directly with existing PCB sampling data to gain insight into the relationships between the distribution of PCBs and volatile organics at the site.

Phase 1: Groundwater Monitoring

Additional groundwater sampling and analysis is required primarily for three reasons: to confirm preliminary results obtained from earlier volatile organic analysis of groundwater samples, to test the hypothesis developed concerning potential sources of volatile organics at the TRW site, and to establish a baseline for judging the effectiveness of future remediation.

A short-term groundwater investigation will be conducted first, to confirm earlier results and to assist identification of potential sources of volatile organics at the Minerva Site. Thus wells previously exhibiting detectable concentrations of volatile organics will be sampled again. In addition, wells downgradient of South Pond, the wax ditch, and the rubble pile will be sampled to determine which if any of these potential sources may be contributing to concentrations of volatile organics observed in groundwater during earlier analysis. Wells 1*, 9, 10, 11, 12, 13, 13a, 14, 18, 19, 20, and 21 will be sampled. Well locations are shown in Figure 1. Each well will be sampled twice within a 2-week period, and all samples collected will be subjected to a full volatile organic (VOC) scan. The short-term groundwater investigation therefore involves collection and complete VOC analysis of 24 samples.

Of the wells listed above, those consistently exhibiting concentrations of volatile organics above background will be sampled monthly for 1 year. This long-term monitoring program will provide a baseline of data to judge the effectiveness of future remediation. It is estimated that six wells will be included in the long term investigation. Samples collected during the long-term monitoring program will be analyzed for

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*Well 1 serves as an upgradient control.

the one volatile organic component exhibiting the highest average concentration in each well during the short term investigation. Such "surrogate" analysis is intended primarily as a cost saving measure and will not impact the integrity of the overall program. Once per quarter, samples collected for long term monitoring will be subjected to a complete volatile organic scan to test for changes in the relative concentrations of volatile organic components and reconfirm the validity of surrogate analysis. Therefore, the long term groundwater investigation will likely involve (over the space of a year) collection of 48 samples for surrogate analysis and 24 samples for VOC analysis.

Phase 2: Sediment Sampling in South Pond and the Wax Ditch

Sediments in South Pond and the wax ditch will be sampled and analyzed for volatile organics because available information about past plant practices suggests that VOC components detected in groundwater may have initially been introduced into the environment via the wax ditch and, subsequently, South Pond. Provided, that results of the short term investigation outlined in phase 1 confirm that volatile organics are present in groundwater downgradient of the site, core samples of sediments in South Pond and the wax ditch will be collected to determine distribution of VOCs in these areas. Analysis of sediment samples will be used to estimate the extent of movement of volatile organics from these sources and confirm that specific components present in groundwater parallel those detected in pond and ditch sediments.

Five core samples will be obtained from South Pond in the approximate locations depicted on the grid map of Figure 2. Actual sampling locations will be depicted on the same grid map and accompany the final analysis report. Cores will be sunk to a sufficient depth to allow analysis of the strata underlying the pond sediments. Samples from each core representing the surface of the sediment, sediment at a depth of 1 foot, and the clayey strata underlying the sediment will be analyzed for VOCs. Thus 15 samples will be collected from South Pond and analyzed for VOCs.

Four core samples will be obtained from the sediment (sludge) in the wax ditch in the approximate locations depicted on the grid map of Figure 3. Actual sampling locations will be denoted on the same map, once sampling is completed, and be incorporated into the final analysis report. Cores will be driven to sufficient depth to allow analysis of the strata underlying the ditch sediments. Samples from each core representing the surface of the sediment, the ditch sediment at 1-foot depth, the ditch sediment at 2-foot depth, and the deepest sample of strata underlying the ditch (which can be practically retrieved without use of a drilling rig) will be analyzed for VOCs. Thus 16 wax ditch samples will be collected and analyzed for VOCs, and a total of 31 samples will be collected and analyzed for VOCs in phase 2 of the sampling program.

<u>Phase 3: Soil Sampling in the Rubble Pile</u>

Soil in the rubble pile will be sampled and analyzed for volatile organics to determine the distribution of VOCs in

FIGURE 2

PROPOSED LOCATIONS OF CORE SAMPLES TO BE COLLECTED IN SOUTH POND

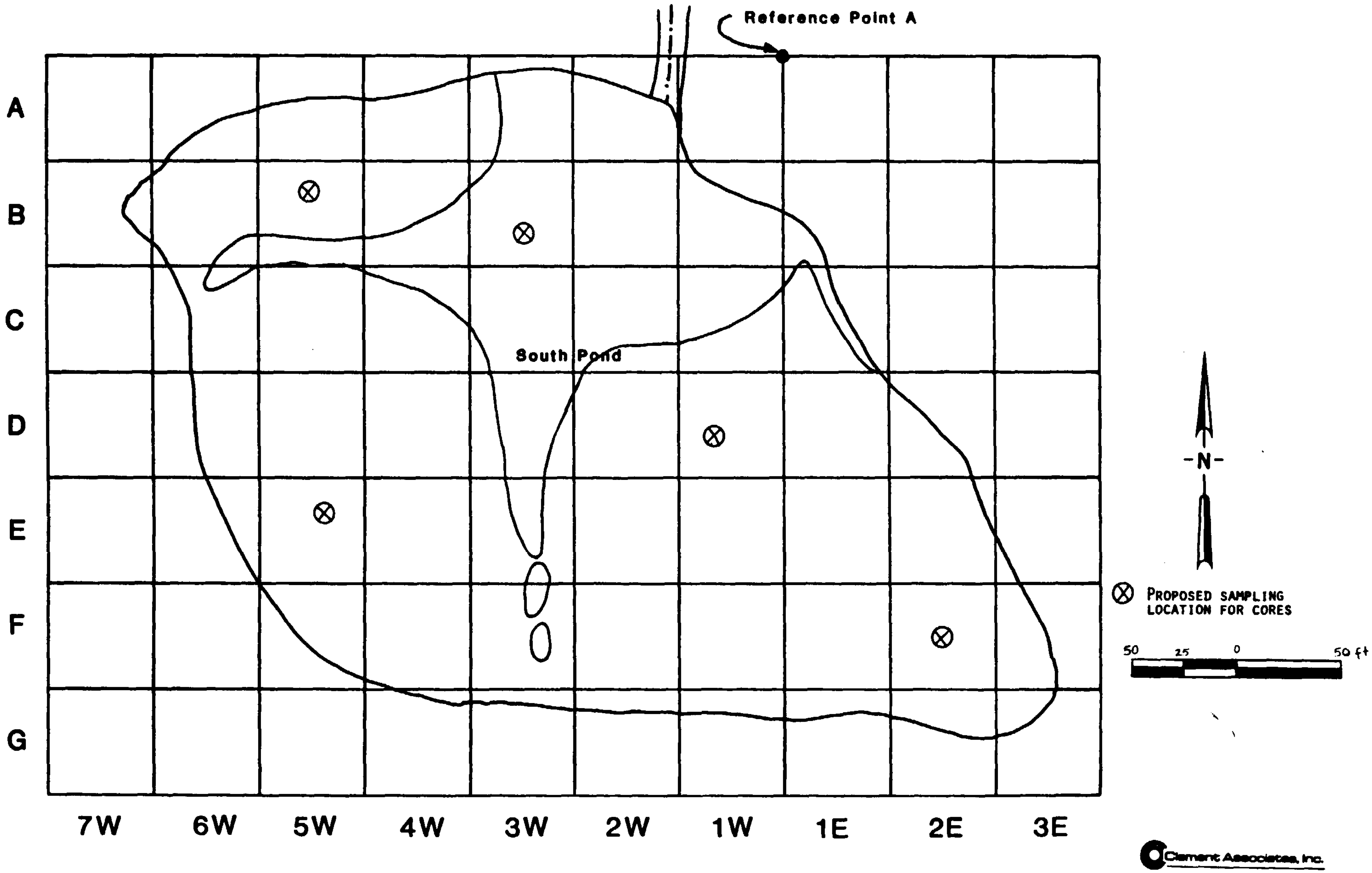
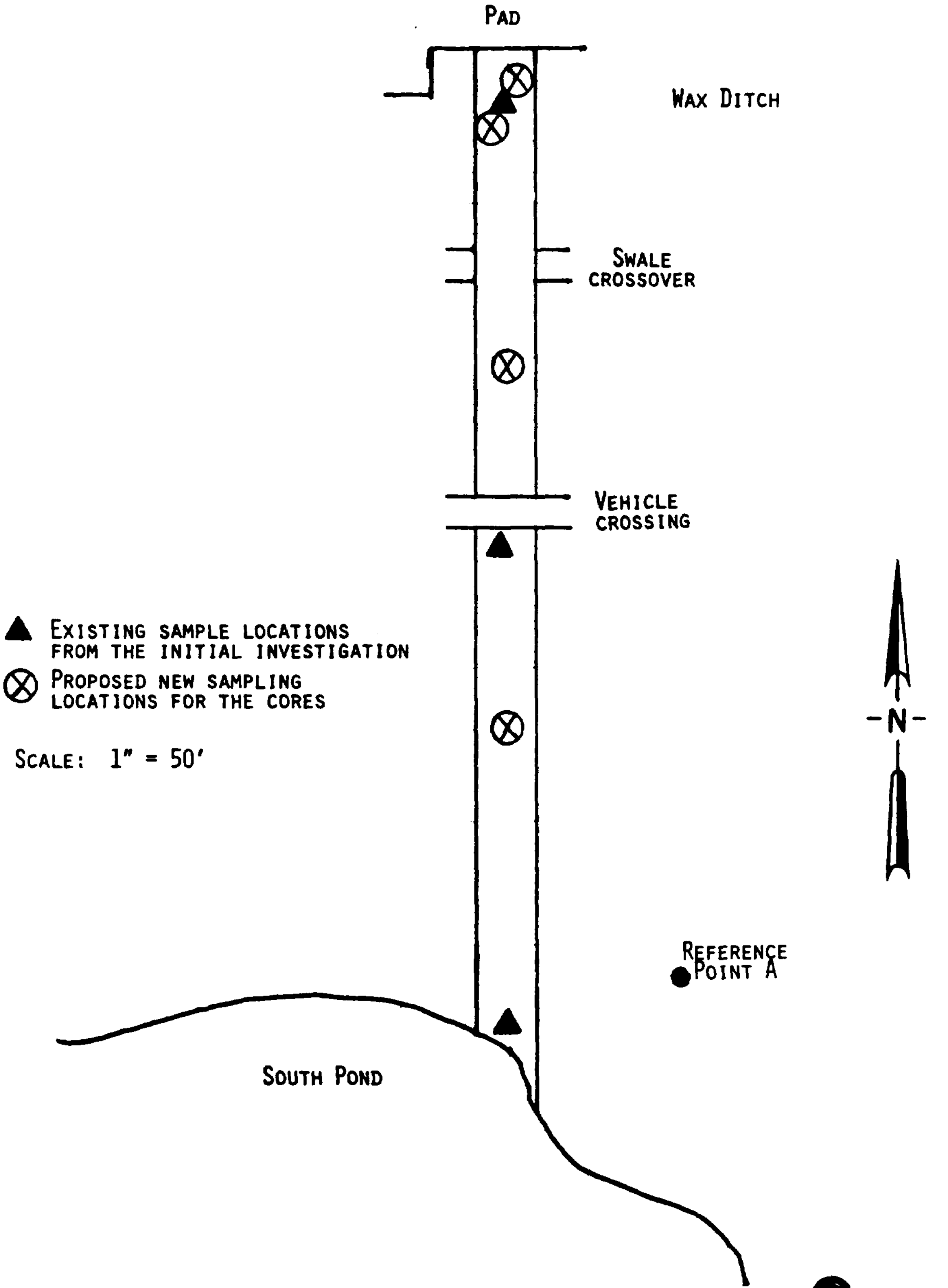


FIGURE 3
PROPOSED LOCATIONS FOR CORE SAMPLES IN THE WAX DITCH



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this area. Phase 3 of this sampling program will be required if wells 13, 13a, or 14 consistently show detectable concentrations of volatile organics during the short term phase 1 study. Positive results in these well would imply that the rubble pile is a potential source of VOCs and available information about past plant practices suggests that sediments in the wax ditch and South Pond may have been deposited periodically in the rubble pile.

If phase 3 is required, eight soil cores will be collected in the rubble pile in the approximate locations depicted on the grid map in Figure 4. Actual sampling locations will be denoted on the same map and be incorporated into the final analysis report. Cores will be driven to a depth of 5 feet. Samples from each core representing soil (or other materials in the rubble pile) at 1-foot depths, 2-foot depths, and 5-foot depths will be analyzed for VOCs. Thus a total of 24 samples will be collected and analyzed for VOCs in Phase 3 of this study.

The sampling program outlined above is expected to provide data sufficient to determine the potential impact of sources of volatile organics at the TRW Minerva site. If the information developed during this study suggests that further investigation is required, such studies will be considered. In addition, the effectiveness of the proposed remediation on reducing contributions of volatile organics to groundwater under the site, will be estimated from the data developed. The effectiveness are added to all GC/MS samples to ensure consistent quantification. Calibration curves are also constructed and routinely verified for each batch (up to 20 samples) of non-GC/MS samples.

Analytical Precision and Accuracy

Surrogate spikes are added to GC/MS samples to monitor acceptable constituent recoveries. In addition, the quality control samples listed below are systematically inserted into the laboratory analyses to routinely assess and document acceptable analytical precision and accuracy.

Method Blanks - A "clean" matrix is passed through the entire analytical system to detect any possible interferences.

Duplicate Samples - Duplicate sample analyses yield actual analytical precision data.

Matrix Spikes - Samples are quantitatively "Spiked" with analyte to yield actual analytical accuracy data.

Blind Standard Spikes - The Quality Assurance Supervisor prepares surrogate standards for analysis by the laboratory to establish actual analyte recovery data.

These quality control samples comprise 10% of all laboratory analyses. All surrogate recovery, precision, and accuracy must meet EPA method specifications to approve the analyses.

APPROVALS

ALERT Inc. / Wadsworth Testing Laboratories, Inc. maintains Ohio Dept. of Health laboratory certification for the analysis of drinking water and has been inspected and approved for work on "Superfund" hazardous material clean-up projects by the U.S. Army Corps of Engineers.

C. Field Log Book

All information pertinent to a field survey and/or sampling must be recorded in a log book. This must be a bound book, preferably with consecutively numbered pages that are 21.6 by 27.9 cm (8.5 by 11 inches). Entries in the log book must include at a minimum, the following:

- The sampler's name and address
- The sampling methodology
- The time and date each sample was collected
- The nature of the sample (e.g., soil, sediment, wax residue)
- Relevant observations (odors, colors, moisture, etc.)
- The sampling location
- A description of the sampling location
- references such as maps or photographs of the sampling site.

Sampling locations should be reported with an accuracy of 1 foot, and depths with an accuracy of 0.5 feet. Distances denoted in tables represent the middle value of these increments (e.g., a 1.0-foot depth means the sample is at a depth lying between 0.5 and 1.5 feet.) The log book must be protected and kept in a safe place.

D. Chain of Custody Record

To establish the documentation necessary to trace sample possession from the time of collection, a chain of custody record must be filled out and accompany every sample. This record is essential if the sample is to be introduced as evidence in litigation.

The record must contain at least the following information:

- Collector's sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Tenure of possession
- Signatures of persons involved in the chain of possession
- Inclusive dates of possession.

E. Sampling Precautions and Protective Gear

Proper safety precautions must be observed when sampling in PCB-contaminated areas of the site. Accordingly, the following protective gear must be worn at all times when sampling is being conducted:

- Tyvek suits
- Neoprene rubber gloves
- Rubber boots

All equipment removed from the site must be decontaminated or disposed of in an appropriate manner.

APPENDIX 4

SPECIFICATIONS FOR LABORATORY QUALITY ASSURANCE PROCEDURES FOR THE TRW, MINERVA SITE

FROM: ALERT, INC., P.O.BOX 208, CANTON, OH 44701

ALERT
ANALYTICAL LABORATORIES AND ENVIRONMENTAL RESPONSE TEAM

P.O. Box 208 CANTON, OHIO 44701 □ 24-Hour ALERT LINE (216) 454-8304

LABORATORY QUALITY ASSURANCE

ALERT Inc. and its parent firm, Wadsworth Testing Laboratories, Inc. utilize only USEPA approved equipment and procedures. The quality assurance procedures recommended in these USEPA analytical methods and the "Handbook for Analytical Control in Water and Wastewater Laboratories" EPA-600/4-79-019, are the basis for ALERT Inc's laboratory quality assurance program. ALERT's laboratory quality assurance program requires laboratory chain-of-custody documentation, continual instrument performance specifications, mandatory standardization schedules in combination with regular calibration checks, and routine surveillance and documentation of accepatable analytical precision and accuracy through systematic inclusion of quality control samples into all laboratory analyses.

SAMPLING

All sampling is performed in accordance with USEPA or accepted concensus methodologies. Samples are permanently labeled, recorded in the Field Sample Log, and appropriately preserved for transport to the laboratory. Chain-of-Custody forms and sample seals are utilized as necessary. Sample duplicates and field blanks are routinely collected for inclusion into the Analytical Quality Assurance Program.

ANALYSIS

A Quality Assurance Supervisor implements an Analytical Quality Assurance Program designed to ensure and document meaningful analytical results.

Documentation

All sample chain-of-custody, preparation, extraction, and pertinent analytical instrumental information is recorded in bound, consecutively numbered analytical logbooks or computer data systems.

> Field Sample Log - Documents all pertinent field data for each sample.
>
> Lab Sample Logs - Documents the date, time, description, preparation and extraction of all samples submitted to the laboratory for analysis.
>
> Instrument Log - One for each analytical instrument to record the nature of the sample, raw data, and pertinent analytical parameters necessary to assist the analyst in evaluating the sample results and instrument performance.
>
> Sample Result Log - Documents results of all sample analyses.
>
> Q.A. Data Log - Documents all data generated by the Analytical Quality Assurance Program.

Instrument Performance

All analytical instrument performance specifications are maintained in accordance with specified EPA method criteria. All GC/MS units are monitored every eight (8) hours to ensure that instrument response on decafluorotriphenylphoshine (DFTPP) is within EPA specifications. Three (3) point priority pollutant calibration curves are created for quantification purposes and are verified at least once every eight (8) hours. In addition, internal standards of remediation will also be monitored long term with a continuing groundwater sampling and analysis program so that potential future problems can be readily identified, evaluated, and addressed.

APPENDIX

PROTOCOLS FOR SAMPLE HANDLING

A. Sample Labels

Sample labels (gummed paper labels or tags are adequate) must include the following information:

- Name of collector
- Date and time of collection
- Place of collection
- Collector's sample number, which uniquely identifies the sample.

A consistent set of sampling numbers should be developed for this protocol and labels will be numbered accordingly.

B. Sample Seals

Sample seals are used to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory. Gummed paper seals may be used for this purpose. The paper seal must include, at least, the following information:

- Collector's name
- Date and time of sampling
- Collector's sample number (identical with the number on the sample label)

The seal must be attached so that it is necessary to break it in order to open the sample container.